TECHNICAL EVALUATION PLAN - DIPEL 6L SPECIAL PROJECT PACIFIC NORTHWEST REGION 1988

FOREST SERVICE

FOREST PEST
MANAGEMENT
DAVIS, CA

MAY 1988
FPM 88-7

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

FPM 88-7

TECHNICAL EVALUATION PLAN - DIPEL 6L SPECIAL PROJECT PACIFIC NORTHWEST REGION 1988

Prepared by:

Technical Evaluation Committee -

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May 1988

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PREFACE

The Director, Forest Pest Management, Pacific Northwest Region (R-6) appointed a technical committee on March 2, 1988, to develop a plan to evaluate the operational use of Dipel 6L. The evaluation will be concurrent with the 1988 R-6 western spruce budworm control project.

The Committee consists of the following:

Abbott Laboratories representatives

Incident Commander, representatives Barlow Spray Unit--George Berscheid and Craig Smith-Dixon

FS Research--Roy Beckwith

FS Forest Pest Management--Jesus Cota, Roger Sandquist, Iral Ragenovich, Bruce Hostetler, Steve Howes, and Jack Barry--Chairman

The Committee met in Portland, Oregon on March 8, 1988 and April 21, 1988 to discuss the scope of the evaluation and to develop a plan to evaluate the operational effectiveness of Dipel 6L. Notes of these two meetings were prepared and provided the Director, FPM (R-6) and committee members.

The evaluations recommended in this plan are considered minimum for an adequate evaluation of Dipel 6L applied operationally.

Jack Barry
Chairman
Technical Evaluation Committee

TECHNICAL EVALUATION PLAN
Dipel 6L Special Project
Pacific Northwest Region
1988 Western Spruce Budworm Control Program

INTRODUCTION

Advancements in the development of ultra low volume (ULV) application of pesticides provides opportunities to improve efficacy and efficiency of aerial application. This equates to reducing the cost to apply pesticides.

ULV is the application of undiluted pesticides at volumes less than one gallon per acre and frequently at rates less than 0.5 gallons per acre. Most ULV sprays have a low rate of volatility that allows application in low relative humidities.

The principles of ULV application differ from those of LV application. The 1988 spray program represents a transition between the old way (LV application) and the new way (ULV application). Requirements for effective ULV application include atomization of a narrow spectrum of small drops, proper aircraft calibration, flight profiles near the canopy, and wind. Wind is needed to break up stable air near the canopy, to accelerate turbulence at canopy height, and to provide energy to impact drops on foliage. Effective ULV application of low volatile sprays is dependent upon application in winds greater than 6 mph.

Covering the target area is dependent upon producing approximately the same number of spray drops as conventional LV application. Research has shown that two drops of Bacillus thuringiensis (B.t.) per needle will produce the desired western spruce budworm mortality. To achieve this in ULV applications the pesticide is atomized into finer drops. To illustrate this point a 400 micrometer diameter drop (a common drop size in LV application) equates to 8,000 drops 20 micrometers in diameter. Therefore, the process is to reduce volume, increase number of drops, and achieve the same or greater deposit as with LV application.

Field studies by U.S. and Canadian researchers have demonstrated that drops between 5 and 50 micrometers are the most frequent spray drop sizes observed on Douglas-fir and true fir foliage. Some researchers argue for drops as small as 5 micrometers. But the problem is complex. The optimum drop size range is dependent upon a relationship of toxin in the drop and number of drops depositing on the target foliage. The number and size of drops may indeed vary depending upon the pesticide, tree phenology, foliage development, biology of the insect, temperature, relative humidity, and wind.

Researchers in eastern Canada and state of Maine have demonstrated the feasibility of ULV application of B.t. to control the spruce budworm. In fact, ULV has been used with apparent success by all the eastern provinces. The literature is somewhat wanting, however, as the number of B.t. products available has precluded replicating operational use from one year to another. There have been several B.t. products, potencies, and rates tested and used operationally over the past several years. This is further complicated by use of large aircraft such as the DC-4, DC-6, TBM, and Dromader M-18; and various types of atomizers. And there is another significant difference.

The eastern operations, for the most part, were conducted over relatively flat terrain, and during cool temperatures and high relative humidities. Results of field experiments and control operations in the East can only be used as guidelines in developing operational procedures for use of ULV in the West.

ULV operations have been tried on a limited scale in the West--sometimes with success. The feasibility of ULV application, however, is yet to be demonstrated on a large scale in the West as a control technique for defoliators of coniferous forests.

One of the problems confronting the Forest Service (FS) is understanding the biological, physical, and chemical nature of the ULV pesticide as they relate to atomization, flow rate, weather, and biological activity. The products have changed from year to year and the FS simply has not had the opportunity to evaluate operationally the new B.t. products in an operational mode. FS Research, likewise, has not had the opportunity to adequately test the products for efficacy.

Simply stated, the FS needs to evaluate on an operational scale the feasibility of ULV application of B.t. Is it possible to deliver effective doses of a low volatile B.t. applied at 42.7 ounces per acre to control western spruce budworm in Douglas-fir foliage? There is ample evidence to support caution in the expectation of success. On the other hand, we have gained considerable knowledge in understanding spray behavior and the influence of weather and terrain.

It is incumbant upon the FS to improve control operations and to use this knowledge in conducting a operational control project.

BACKGROUND

The 1988 western spruce budworm control program provides the FS an opportunity to gain operational experience in ULV application. Four undiluted B.t. formulations will be evaluated, two produced by Abbott Laboratories and two produced by Sandoz Crop Protection. Product/acreages are as follows: Thuricide 32LV/481,572; Thuricide 48LV/20,200; Dipel 6AF/18,228; and Dipel 6L/183,000. Note that these figures are approximations. Results of these operations will provide insight into the feasibility of using ULV applications of B.t. to control the target pest.

Additionally, more intensive evaluations of product effectiveness will be made on the pilot test using Thuricide 48LV and Dipel 6AF, and on a special project using Dipel 6L.

The Dipel 6L Special Project will be conducted on approximately 6,000 acres within the Barlow Unit, Mt. Hood NF. The entire Barlow Unit will be treated with Dipel 6L; however, the Dipel 6L Special Project biological evaluations will be conducted only on the 6,000 acres. The loading, handling, and storage of Dipel 6L, however, will be evaluated throughout the Barlow Unit as per this evaluation plan.

OBJECTIVE

The objective of the Dipel 6L special project evaluation is to evaluate the operational use of Dipel 6L applied undiluted at 42.7 ounces per acre.

SCOPE

This plan consists of sub plans enclosed as appendices and listed as follows:

Sub Plan	Responsible Person
Dipel 6L Handling, Storage, Loading, and Monitoring on Barlow Unit (Recommendations) (Appendix 1)	Abbott Labs
Evaluation and Quantification of the Physical Characteristics of Dipel 6L During Operational Use (Appendix 2)	J. Cota
Entomological Plan (Biological Monitoring - Development, Pre-Spray, Post-Spray, Defoliation, and Bio-Assay) (Appendix 3)	B. Hostetler and D. Scott
Spray Deposit Foliage Assessment (Appendix 4)	C. Wiesner, RPC
Spray Deposit Kromekote Sampling (Appendix 5)	J. Barry

RESPONSIBILITIES

George Berscheid, Incident Commander, has overall responsibility for execution of the technical evaluation plan.

Jack Barry is responsible for preparation and publication of the plan. He will be on site for a limited time to coordinate the initial field implementation of the plan.

Jesus Cota is responsible to the Incident Commander for on-site conduct and coordination of the plan, and evaluation of Dipel 6L handling, storage, and loading procedures as outlined in this plan.

Jack Barry is responsible for evaluating the Kromekote samplers used in the 6,000 acres 3 evaluation blocks treated with Dipel 6L and Day Glo.

Don Scott is responsible for conducting the bio-assay.

Bruce Hostetler is responsible for all biological monitoring.

RPC contractor is responsible for the foliage assessment procedures.

Each named person will evaluate and report data within his/her respective activity. Jack Barry will prepare a final report that consists of reports based upon the individual sub plans. The report will be published December 1988.

ALTERNATE PLAN, OREGON FORESTRY PRACTICES ACT

The FS requested and was granted an alternate plan to allow application of Dipel 6L in winds up to 10 miles per hour with no relative humidity restrictions. The Alternate Plan is enclosed as Appendix 6.

DIPEL 6L HANDLING, STORAGE, LOADING, AND MONITORING ON BARLOW UNIT

These recommendations were provided by Abbott Laboratories and include a contingency plan to insure Dipel 6L sprayability.

Oil based, emulsifiable suspensions of Dipel 6L and 8L are formulated with enough emulsifier to permit mixing with water at ratios greater than 50:50 water to undiluted product. Mixing of product with less than 50% water will result in an invert emulsion - a thick, viscous material that is difficult to pump and spray. Combinations of undiluted Dipel 6L or 8L with even low percentages of water (5-10%) can cause thickening, especially if water is allowed to remain in pump lines, strainers, booms and atomizers. Therefore it is important to avoid any contact of undiluted product with water. The following recommendations center around this basic requirement.

BULK STORAGE AND TRANSFERRING

- Tanks, fill lines and pumps for bulk storage should be clean and free of water prior to addition of undiluted Dipel 6L and 8L. Rinse all equipment with clear water and drain thoroughly.

- Flush lines, pump strainers, metering devices and tanks with an oil miscible, organic solvent (diesel, kerosene, crop oil, glycol) to evacuate any residual water. After flushing, remove solvent. Used solvent can be retained for further use if not contaminated with water. Check and clean strainers.

- Dipel can be pumped into bulk tanks from tankers or 55-gal. drums following solvent flushing. Prior to unloading tankers or drums, mix product through recycling from bottom to top in tankers, and rolling and/or shaking drums. It is recommended that pumps used for transferring product be a minimum of 5 Horsepower and be fitted with 2" ID non collapsible lines. Pump product either directly from the outlet pipe (tanker) or threaded bunghole of drums. A tapered stand pipe can also be used to empty drums.

- Upon prolonged standing in storage, Dipel 6L/8L will undergo slight separations of oil and solid phase components. Regular recycling of product by pumping from bottom to top of bulk storage tanks every 3 days will maintain even consistency. Recycle at least the entire bulk volume once. Make sure recirculation within tank is adequate to remix the entire volume.

- Recycle product in same manner prior to transferring to aircraft.

- In-line screens or filters should be at least 16 mesh, but no finer than 50 mesh. (consult manufacturer's recommendations on screen size.)

- Bulk storage tanks should be fitted with a rain proof hatch that is vented.

- Empty drums and bulk tanks should be triple rinsed. Empty drums should be disposed of in an appropriate manner.

AIRCRAFT SPRAY SYSTEM RECOMMENDATIONS

- Flush spray system with clear water and drain completely.

- Refill spray tank with approximately 50% more volume than sump (25-50 gallons) of oil solvent (diesel, kerosene, crop oil, glycol). Recirculate solvent throughout system and spray out through atomizers, collecting spent solvent in waste containers. Drain solvent from aircraft system completely.

- Fill spray system with undiluted Dipel 6L or 8L. Open outer boom ports or boom end plugs and prime boom with product until excess runs from ends. Recap boom.

- Follow manufacturer's recommendations for in-line strainer sizes. Generally, a canister-type strainer of at least 16 mesh size is adequate for most coarse nozzle orifice applications. Up to 50 mesh strainers should be used where small orifices are used, e.g. TeeJet D4 and less. (Consult manufacturer's specifications.)

- If a flow meter is used, use the correct flow turbine according to manufacturer's suggestions and calibrate it to the desired flow rate. The desired flow rate should be well within (midway) the advertised accuracy range of the flow turbine. Due to the different viscosity of Dipel formulations to water, a different flow factor calibration will be necessary.

- Maintain bypass agitation during spray operation.

- Pump out unsprayed Dipel 6L/8L from aircraft spray system at the end of each spray session.

- Exclude water from entering spray tank. Ensure that hopper lid gasket is tight fitting and that hopper lids are covered with plastic sheathing during rainy periods.

CLEANING TRANSFER, MIXING AND SPRAY EQUIPMENT

At conclusion of the spray program, equipment should be cleaned according to these recommendations.

Remove in-line screens, nozzle screens and nozzles, and clean these either in solvent (undiluted applications) or detergent water solution (diluted applications). Micronair variable restrictor units should be set at #13 or pulled out to the "full open" position.

For undiluted applications, (1) load system with an organic solvent (diesel, kerosene, jet A, glycol, crop oil) in sufficient volume to dilute and remove undiluted Dipel residues from internal walls of the pump and transfer system. In aircraft hoppers, 30-40 gallons of solvent should be sufficient. Agitate and flush system out. (2) Add a detergent/water solution, agitate and flush system out. (3) Final rinse equipment with clear water and drain. (4) Replace screens and nozzles.

After a long operational spray program, it may be necessary to dismantle complex or precision equipment like flow meters and inspect for solids accumulation at "dead" points in the system. Mechanical removal and rerinsing with solvent is recommended prior to long term storage.

AIRCRAFT CALIBRATION

Proper calibration and spray atomization are paramount to achieving optimal efficacy. Several methods exist for calibrating flow rates in aircraft. The

one covered here pertains to aircraft equipped with Hydraulic or Electrical operated pumps

These systems can be accurately calibrated on the ground as follows:

1) Determine the number of acres covered per minute based on the aircraft speed and swath width chosen. Table:

ACRES PER MINUTE

SWATH WIDTH - FEET

	30	35	40	45	50	75	100	200	300	500
75	4.5	5.2	6.0	6.7	7.5	11.2	15.0	30.0	45.0	75.0
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0	48.0	80.0
85	5.1	5.9	6.8	7.6	8.5	12.7	17.0	34.0	51.0	85.0
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0	54.0	90.0
95	5.7	6.6	7.6	8.5	9.5	14.2	19.0	38.0	57.0	95.0
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0	60.0	100.0
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0	66.0	110.0
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0	72.0	120.0
130	7.8	9.1	10.4	11.7	13.0	19.5	26.0	52.0	78.0	130.0
140	8.4	9.8	11.2	12.6	14.0	21.0	28.0	56.0	84.0	140.0
150	9.0	10.5	12.0	13.5	15.0	22.5	30.0	60.0	90.0	150.0

Acres per minute can also be determined by the following formula:

$$\text{Ac/min} = \frac{\text{Airspeed (mph) x swath (feet)}}{495}$$

2. Determine gallons per minute (GPM):

$$\text{GPM} = \frac{\text{Ac/min x Spray Volume/Ac (oz)}}{128 \text{ oz}}$$

3. Determine flow per nozzle/atomizer per minute:

$$\text{Flow/atomizer/minute} = \frac{\text{GPM}}{\text{No. atomizers}}$$

4. Load product into aircraft pesticide tank(s) (at least 30-50 gallons) and operate pump to charge the entire spray system. Outer atomizer should be connected to outermost boom port, or bleed line installed, to expel all pockets of air in the boom. Alternatively, product can be pumped out momentarily through open ends of boom.

5. Once the boom is charged with product, place collection buckets or bags beneath atomizers. Consult atomizer manual or Dipel technical bulletin for approximate orifice and pressure settings. Start pump and pressurize system at desired pressure for 1/2 or 1 minute, collecting emitted product into buckets. Use a graduated container to volumetrically measure the amount of product discharged per minute per atomizer. Compare this figure with the proper calibrated volume.

   Eg. Application rate = 43 oz/Ac. (0.33 gal.)
   Aircraft coverage = 33 Ac/min.
   Required total volume per minute = .33 x 33 = 10.9 GPM
   If 8 atomizers: Gal/atomizer/min = 10.9/8 = 1.4

   Adjust pressure and/or orifice setting if necessary to obtain desired output. Repeat exercise until proper emitted volume is obtained.

   Once proper calibration is achieved, compare to flow meter reading and adjust flow setting or correction factor as needed.

SPECIAL HANDLING CONSIDERATIONS: Cold Temperature Induced High Product Viscosity

Certain production series of Dipel 6L have exhibited tendencies to high fluid viscosities at product temperatures below 50°F. Under moderately low product temperatures, i.e. 45°F, changes in flow rate and calibration could occur. Under extremely cold product temperatures, i.e. 32°-40°F, difficulty in pumping product with typical operational equipment might result. At cold temperatures, viscosity of these production lots could reach as high as 5000 or 6000 centipoise (cps). Through testing, Abbott has determined that potency (determines solids level) and physical characteristics of the primary B.t. powder are integral to product viscosity at low temperatures. Furthermore, we have found that maintenance of viscosity below 2000 cps over the range in operating temperatures (32°-90°F) will ensure consistent smooth handling and unchanging flow patterns. With this knowledge, Dipel 6L for use in cold climates will be manufactured from highest potency primary B.t. powders and be of a solid content that will prevent viscosities exceeding 2000 cps

at 32°F. Recent tests with this product in Oregon have indicated no handling problems at cold temperatures.

For the 1988 spray program, Abbott fully expects Dipel 6L to handle satisfactorily over any temperature encountered. This includes all aspects of storage, transfer, recirculation, and aircraft operation. In the unlikely event that an emergency should arise, provisions will be made for heating product on site as per USFS contract specifications (see attached). Abbott reserves the right to modify product heating specifications once the aerial contractor selected for the Barlow Unit is availed to us. However, as an additional facet of the Barlow Unit, Dipel 6L intensive evaluation program, we recommend that product reserved for this specific use be left unheated for the purpose of monitoring.

Monitoring of Dipel 6L

The following criteria are proposed for monitoring physical characteristics of Dipel 6L handling. Monitoring should be performed on a daily basis.

1. Product Temperature: As recorded each morning after product is recirculated or rolled in a drum.

2. Product Viscosity: As measured with a Zahn cup and stopwatch replicated thrice. Zahn cup time will be compared to a standard curve correlating to viscosity profile of 500-2000 cps.

3. Subjective Evaluations on Handling: Expressed in descriptive terms from poor - fair - good.

   Categories:

   pumping
   spraying
   flow meter operation
   strainer appearance
   calibration

It is suggested that the foregoing criteria be incorporated in a daily log or checklist to be used by base operations personnel.

TECHNICAL PROPOSAL FOR OREGON WSBW PROGRAM

I. Contingency Action Plan to Insure Dipel® 6L Sprayability

1. DIPEL 6L to be sold to the USFS for Oregon will be formulated with the highest potency (best grade) technical powder in order to minimize temperature related viscosity increases. A temperature/viscosity profile of this material will be provided, with associated flow rate patterns.

2. At a threshold product viscosity of 2000 centipoise, regardless of temperature, direct action to raise product temperature will be initiated. Action will be based in viscosity criteria rather than product temperature since viscosity is the only true measure indicative of flow properties and any associated handling problems.

   (a) Temperature thermowells and indicators will be installed on main bulk storage tanks. Immersion type thermometers are considered to be adequate for smaller mobile tank units. Main bulk tanks should have inlets and outlets positioned so as to provide uniform product mixing and turnover. In conjunction with temperature monitoring, during periods of unusually cold atmospheric temperatures, product viscosities will be checked daily in the morning using Zahn or paint type viscosity cups. Flow rate through Zahn cups will be accurately correlated with laboratory viscosities measured with a Brookfield viscometer.

   (b) For each large bulk storage tank (10,000 to 30,000 gal.)

      1. Two emergent heaters (Model 2E934) with 60 degrees F-250 degrees F thermostats. Cost per heater unit $418.25.
      2. One solar blanket to cover outer surface of storage tank. Cost per blanket unit $263.83.
      3. Two portable electric generators (Model 4W112) to provide power to emergent heaters. Cost per generator unit $1364.28.

   Total cost per storage tank:

Item A -	$ 836.50
Item B -	$ 418.25
Item C -	$2,728.56
	$3,983.31

(c) Portable heating for aerial applicator ground transport trucks tank capacities - 1000 to 5000 gals.

1. One emergent heater (Model 2E934) with 60 degrees F to 250 degrees F thermostats. Cost per heater unit $418.25.
2. One solar blanket to cover outer surface of tank when it is parked at destination point. Cost per blanket unit $150.00.
3. One portable electric generator (Model 4W112) to provide power to emergent heater. Cost per generator unit $1,364.28.

Total cost for heating supply for ground transport trucks:

Item A -	$ 418.25
Item B -	$ 150.00
Item C -	$1,364.28
	$1,932.53

(d) 55 Gallon Drums

1. Drums to be painted black to absorb heat.
2. Drums stored outside will be covered with solar blankets to increase temperature build-up.

Approx. cost per stock pile = $250.00

Abbott personnel will be available during the operational spray program to assist in monitoring and implementation of the above stated procedures.

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It should be understood that is only a contingency plan. When Abbott is permitted to survey on-site tank storage and remote helo L-Z's we will be better able to provide a more specific action plan.

APPENDIX 1
Revision
May 9, 1988

REVISION

Dipel 6L Handling, Storage, Loading and Monitoring on Barlow Unit (Abbott Recommendations)

Note: This revision should be attached to USDA Forest Service - Technical Evaluation Plan - Dipel 6L Special Project Pacific Northwest Region 1988, FPM 88-7, Davis, CA.

HANDLING UNDILUTED DIPEL 6L

Combinations of undiluted Dipel 6L or 8L with even low percentages of water (5-10%) can cause thickening, especially if water is allowed to remain in pump lines, strainers, booms and atomizers. Therefore it is important to avoid any contact of undiluted product with water. The following recommendations center around this basic requirement.

BULK STORAGE AND TRANSFERRING

1. Tanks, fill lines and pumps for bulk storage should be clean and free of water prior to addition of undiluted Dipel 6L and 8L. Rinse all equipment with clear water and drain thoroughly.

2. Flush lines, pump strainers, metering devices and tanks with an oil miscible, organic solvent (diesel, kerosene, crop oil, glycol) to evacuate any residual water. After flushing, remove solvent. Used solvent can be retained for further use if not overly contaminated with water. Check and clean strainers.

3. Dipel can be pumped into bulk tanks from tankers or 55-gal. drums following solvent flushing. Prior to unloading tankers or drums, mix product through recycling from bottom to top in tankers, and rolling and/or shaking drums. It is recommended that pumps used for transferring product be a minimum of 5 Horsepower and be fitted with 2" or 3" ID non collapsible lines. Pump product either directly from the outlet pipe (tanker) or threaded bunghole of drums. A tapered stand pipe can also be used to empty drums.

4. Upon prolonged standing in storage, Dipel 6L/8L will undergo slight separations of oil and solid phase components. Regular recycling of product by pumping from bottom to top of bulk storage tanks every 3 days will maintain even consistency. Recycle at least the entire bulk volume once. Make sure recirculation within tank is adequate to remix the entire volume.

5. Recycle product in same manner prior to transferring to aircraft.

6. In-line screens or filters should be at least 16 mesh, but no finer than 50 mesh. (Consult manufacturer's recommendations on screen size.)

7. Bulk storage tanks should be fitted with a rain proof hatch that is vented.

8. Empty drums and bulk tanks should be triple rinsed. Empty drums should be disposed of in an appropriate manner.

AIRCRAFT SPRAY SYSTEM RECOMMENDATIONS

1. Flush spray system with clear water and drain completely.

2. Refill spray tank with approximately 50% more volume than sump (25-50 gallons) of oil solvent (diesel, kerosene, crop oil, glycol). Recirculate solvent throughout system and spray out through atomizers, collecting spent solvent in waste containers. Drain solvent from aircraft system completely.

3. Fill spray system with undiluted Dipel 6L or 8L. Open outer boom ports or boom end plugs and prime boom with product until excess runs from ends. Recap boom.

4. Follow manufacturer's recommendations for in-line strainer sizes. Generally, a canister-type strainer of at least 16 mesh size is adequate for most coarse nozzle orifice applications. Up to 50 mesh strainers should be used where small orifices are used, e.g. TeeJet D4 and less. (Consult manufacturer's specifications.)

5. If a flow meter is used, use the correct flow turbine according to manufacturer's suggestions and calibrate it to the desired flow rate. The desired flow rate should be well within (midway) the advertised accuracy range of the flow turbine. Due to the different viscosity of Dipel formulations to water, a different flow factor calibration will be necessary.

6. By pass agitation is not necessary during application.

7. Pump out unsprayed Dipel 6L/8L from aircraft spray system at the end of each spray session.

8. Exclude water from entering spray tank. Ensure that hopper lid gasket is tight fitting and that hopper lids are covered with plastic sheathing during rainy periods.

CLEANING TRANSFER, MIXING AND SPRAY EQUIPMENT

At conclusion of the spray program, equipment should be cleaned according to these recommendations.

1. Remove in-line screens, nozzle screens and nozzles, and clean these either in solvent (undiluted applications) or detergent water solution (diluted applications). Micronair variable restrictor units should be set at #13 or pulled out to the "full open" position.

2. For undiluted applications, (1) load system with an organic solvent (diesel, kerosene, jet A, glycol, crop oil) in sufficient volume to dilute and remove undiluted Dipel residues from internal walls of the pump and transfer system. In aircraft hoppers, 30-40 gallons of

solvent should be sufficient. Agitate and flush system out. (2) Add a detergent/water solution, agitate and flush system out. (3) Final rinse equipment with clear water and drain. (4) Replace screens and nozzles.

After a long operational spray program, it may be necessary to dismantle complex or precision equipment like flow meters and inspect for solids accumulation at "dead" points in the system. Mechanical removal and rerinsing with solvent is recommended prior to long term storage.

SPECIAL MONITORING AND HANDLING SPECIFICATIONS

The following recommendations have been devised to insure that viscosity of Dipel 6L remains low enough for consistent, smooth application over a wide range of operational temperatures.

MONITORING OF BULK STORAGE (7000 GAL) AND MOBILE BATCH TANKS (2000-4000 GAL)

1. Temperature: Full immersion type thermometers will be installed in the bulk and batch truck tanks. Temperature in degrees Fahrenheit will be recorded twice daily from a central point within the liquid mass in the tanks. Suggested recording times would be 5:00 - 6:00 AM and 9:00 - 10:00 PM.

2. Viscosity: Product viscosity will be measured daily using a #5 Zahn viscosity cup with an orifice diameter of 0.208". This size cup is designed to accurately measure viscosity from 250 to 1200+ centipoise, that is, within the expected range of Dipel 6L. Zahn cups will be supplied by Abbott and returned following conclusion of the project.

   Recommended procedure: Take measurements in all tanks each morning after at least one full volume of the tank is recirculated. Timing should coincide with temperature monitoring. To use the Zahn cup, collect some recirculated product in a bucket or other accessible vessel, dip the cup to fully emerge in product, lift the cup fully out of the liquid and time the discharge of product from the exit hole by means of a stopwatch. Stop timing when a complete break occurs in the discharge stream. Record the elapsed time for cup to empty.

VISCOSITY RELATIONSHIP TO #5 ZAHN CUP

Viscosity (CPS)	Time to Empty
2000	31 sec.
1500	19 sec.
1000	12 sec.
500	8 sec.

We recommend that viscosity be kept below 2000 CPS in order to sustain consistent flow properties. Therefore a Zahn cup time of 20 sec. (approx. 1500 CPS) should provide sufficient margin of safety and is proposed as a field standard.

3. Special Handling - Heating of Product

Dipel 6L to be sold to the USFS for Oregon will be formulated with the highest potency (premium grade) technical powder in order to minimize viscosity variations with temperature. However, extra precautions are recommended as follows:

A. When product temperature falls below 50° F or Zahn cup reading is 20 seconds or greater, product heating should be initiated as described below:

a. Use of Centrifugal Transfer Pump. The transfer and recirculation pump on the bulk storage and batch tanks have been calculated to produce up to 10,000 BTU of heat energy per hour. At the specified temperature/viscosity threshold, begin agitation and continue agitation until ambient temperature rises above 50° F. Product temperature of 7,000 gallons should be expected to increase 1° F for every 2 hours of circulation.

b. Secondary Backup Electric Heat Exchanger. If product temperature falls to 45° F or lower in bulk storage tanks, initiate secondary heating. This will be accomplished using an in-line emersion heater installed as part of the recirculation line of the bulk TANK IN USE. This unit will quadruple heating capacity in conjunction with pump recirculation. Temperature of heated product will be sustained over low temperature periods using solar blankets installed over batch trucks.

Power to the in-line heater will be supplied by standard house current available at the storage site.

B. Solar blankets will be provided to cover batch tanks during prolonged periods of cold temperatures and to be used in conjunction with emergency heating measures.

Costs of equipment:

1.	In line heater (1):	$ 450.00
2.	Solar Blankets ( ):	$1,500.00
3.	Immersion Thermometers (12):	$ 60.00
4.	Zahn cups (12):	$1,200.00
5.	Flow Switch:	$ 100.00
	Total	$3,310.00

Appendex A: Flow Chart for Dipel 6L

TEMP DEG F	PRESSURE (PSI)	Flow in gallons/minute MICRONAIR VRU 7	9	11
33	20	0.83	1.31	2.08
50	20	0.83	1.30	2.01
68	20	0.88	1.42	2.20
33	30	1.13	1.71	2.68
50	30	1.04	1.66	2.54
68	30	1.08	1.74	2,80
33	40	1.29	1.97	3.08
50	40	1.28	2.05	3.10
68	40	1.26	2.04	3.35

EVALUATION AND QUANTIFICATION OF THE PHYSICAL CHARACTERISTICS OF DIPEL 6L DURING OPERATIONAL USE

I. Introduction

This sub-plan details the monitoring procedures to be followed in evaluating the handling properties and the viscosity of Dipel 6L during its operational use for the suppression of the Western Spruce Budworm in the Barlow Unit of the Mt. Hood Project. The overall approach of the plan is to monitor the viscosity of the product on a daily basis to insure that its flowability remains within an acceptable range. This will be accomplished by quantitatively measuring two physical parameters (temperature and viscosity) on a daily basis for each batch of the product contained in every storage tank and batch truck used in the project. Measurements will be performed by operations personnel and data will be recorded in daily logs.

In addition, certain handling characteristics which reflect its physical properties will be subjectively rated to determine the operational considerations that must be met in using this product in future suppression projects. Subjective information on handling of Dipel 6L will be obtained by surveying application equipment managers, aircraft pilots and contractor ground personnel in the project at specific times and locations.

II. Project Responsibilities

The overall responsibility for coordinating and implementing the monitoring plan contained herein is that of the U.S. Forest Service and its personnel assigned to the project. Abbott Laboratories personnel will provide technical advise and assistance in the performance of the product to Forest Service personnel and to the Contractor. In addition, Abbott Laboratories will provide the insulating or heating equipment needed to maintain its product at temperatures which will insure proper viscosity. The selected Contractor will provide the equipment specified in the contract and will insure that the product handling procedures indicated in section III. below are followed. Should Dipel viscosity change to an unacceptable level, the Contractor will also insure that the contingency plan outlined in the Appendix of the Evaluation Plan is implemented with the assistance of Abbott Laboratories.

III. Handling Procedures

A. Transportation, storage and transfer--The formulation of Dipel to be used in the project is an oil based, emulsifiable concentrate which can form a thick, vicious material that is difficult to pump and spray if it is mixed with less than 50% water. Therefore, it is important to avoid any contact of undiluted product with water. Since the undiluted product will be shipped and stored in bulk quantities, the following procedures will be used to insure that

Dipel does not come into contact with water in storage tanks, tank trucks, or spray equipment.

1. Storage tank--Fill lines and pumps for bulk storage chould be clean and free of water prior to addition of undiluted Dipel 6L. Flush lines, pump strainers, metering devices, and tanks with an oil miscible, organic solvent (diesel, kerosene, crop oil, glycol) to evacuate any residule water. After flushing, remove solvent. Used solvent can be retained for further use if not contaminated with water. Check and clean strainers.

2. Dipel can be pumped into storage tank from tankers of 55-gallon drums following solvent flushing. Prior to unloading tankers or drums, mix product through recycling from bottom to top in tankers, and rolling and/or shaking drums. It is recommended that pumps used for transfering product be a minimum of five horsepower and be fitted with two-inch ID non-collapsible lines. Pump product either pipe (tanker) or threaded bunghole of drams.

3. Recycle the entire volume of the storage tank, or tank track once every three days to prevent Dipel from separating into its oil and solid phase components. Recycle product by pumping from bottom to top of tanks making sure that recirculation within the tank is adequate to remix the entire volume. Recycle product in same manner prior to transfering to spray aircraft.

4. In-line screens or filters should be at least 16 mesh, but no finer than 50 mesh. Storage tanks should be fitted with a rainproof hatch that is vented.

B. Aircraft spray system -

1. Flush spray system with clean water and drain completely. Refill spray tank with 50% more volume than sump (25-50 gallons) of oil solvent. Recirculate solvent throughout system and spray out through atomizers, collecting spent solvent in waste containers. Drain solvent from aircraft system completely.

2. Fill spray system with undiluted Dipel and open outer boom ports or end plugs and prime boom with product until excess runs from ends. Recap boom.

3. Follow manufacturer's recommendations for in-line strainer sizes. Generally, a canister-type strainer of at least 16 mesh is adequate for coarse nozzle orifice application. A 50 mesh strainer should be used for smaller orifices such as TeeJet D4 or less. (Consult manufacturer's specifications.)

4. If flow meter is used, use the correct flow turbine according to manufacturer so that the desired flow rate is well within (midway) the advertised accuracy range of the flow turbine.

5. Maintain bypass agitation during spray operation.

6. At the end of each spray session pump out unsprayed Dipel 6L from aircraft spray system.

7. Exclude water from entire spray tank. Insure that hopper lid gasket is tight fitting and that hopper lids are covered with plastic sheathing during raining periods.

C. Cleaning equipment - At conclusion of the spray program, equipment should be cleaned according to these recommendations.

1. Remove in-line, screens, nozzle screens, and nozzles, and clean in solvent (diesel, kerosene, Jet A, clycol, crop oil). Micronair variable restrictor units should be set at #13 or pulled out to the "full open" position.

2. Load system with the organize solvent in sufficient volume to dilute and remove undiluted Dipel residues from internal walls of the pump and transfer system. In aircraft hoppers 30-40 gallons of solvent should be sufficient. Agitate and and flush system out.

3. Add a detergent/water solution, agitate and flush system out. Final rinse equipment with clear water and drain. Replace screens and nozzles.

4. After a prolonged spray program, it may be necessary to dismantle complex or precision equipment like flow meters and inspect for solids accumulation in "dead" points in the system. Mechanical removal and rinsing with solvent is recommended prior to long-term storage.

IV. Monitoring Plan

The objective of the monitoring plan is to insure that the viscosity of Dipel 6L remains within an acceptable range (2,000 cps +5%) so that its flowability will not affect the dosage rate at which the material is being applied (16 BIUs/Acre). This will be done by monitoring the physical properties of the material while in storage on holding tanks and batch truck. The flowrate of Dipel 6L as a function of viscosity will also be monitored on application aircraft by recording boom time for each insecticide load applied. Subjective information on the handling characteristics of the product will be obtained by surveying personnel involved in its handling using a questionaire.

A. Temperature and Viscostiy

The measurement of these parameters will be performed daily on each bulk storage tank, batch truck as part of the duties of the operations personnel. Data will be collected by the Application Equipment Manager (AEM) of each unit and recorded in daily logs.

At a product threshold temperature of 50 F and/or a viscosity of 2,100 centipoise (cps) heating of the material will be initiated using the contingency plan outlined in the Appendix of the project evaluation plan to reinstate the desired physical properties of Dipel 6L (2,000 cps).

The physical measurements to be conducted are as follows:

1. Product temperature
   a. At product temperature above 50 F - temperature will be recorded each morning after product recirculation.

b. At product temperature below 50 F - initiate heating procedures and record temperature every hour until product is heated to 60 F or vicosity returns to 2,000 cps.

2. Product viscosity
   a. Viscosity will be measured using Zahn cup and stop watch.
   b. Viscosity will be measured each morning prior to loading aircraft or batch truck.
   c. At product viscosity greater than 2,100 cps take a sample of the product,initiate heating procedures and record viscosity every hour until product viscosity returns to below 2,000 cps.
   d. The mean of three viscosity readings will be recorded.

B. Flowrate -

The flowrate of Dipel 6L can affect the dosage rate at which the material is applied by the spray aircraft. If the application rate varys by more than 5%, an insufficient amount of insecticide may deposit on the foliage and result in an unacceptable rate of pest mortality. For this reason, boom time will be recorded for each insecticide load applied by every aircraft on the Barlow Unit. The collection of the data will be the responsibility of the aerial observer (AO) and will be fowarded to the Dipel Test Coordinator via the ATL. The following information will be recorded for each load:

1. Aircraft number and type.
2. Load number and time of departure
3. Ambient temperature
4. Boom time (Actual time that the nozzles are applying material)
5. Date and location and spray block number

C. Handling Characteristics -

A subjective rating system will be used to gather information concerning normal field operations conducted during spray applications. The ratings will be conducted by filling out questionaires prepared for personnel involved in the actual handling of the product. These personnel would be the application aircraft pilots, the contractor's ground support personnel, and the AEM's. At specified times (Every 3-4 days) during the operation, a specific application team will be questioned about their experiences with the product during the course of the spray day. The surveyed teams will represent all the types of equipment used in the project and will provide a sample of all operational conditions and locations.

Three rating categories will be used for the subjective information, good, fair, and poor. The handling categories to be rated are: 1. Insecticide storage and transfer, 2. Insecticide application and 3. Equipment operation. See Table 1. for criteria of the rating system.

V. Spray Standards

1. Weather - Moisture, wind, humidity, air temperature and ground temperature are all important factors that affect spray drift and the upward rsing of spray droplets. Standards for these parameters are

established in the operations plan to guide all Application Team Leaders in determining when spray operation should be suspended. Likewise, a standard for Dipel will be included.

2. Insecticide -

a. Temperature - Minimum allowable product temperture is 50 F. No loading or spraying should be attempted if the temperature of the product at the batch truck is at or below the indicated level. Recirculate batch and re-check tempeature. If temperature is below 45 F initiate heating procedures and notify D.M.C. and Dipel Test Coordinator.

b. Viscosity - Permisible viscosity range is 2,000 cps + 5%. Do not load or spray material when the viscosity exceeds 2,100 cps. Initiate heating procedures for batches with viscosity higher than this level.

c. Visual appearance - Do not load or spray product batch if it appears clumpy or thick or separates into oil and solid phases.

VI. Spray Operations

The operations unit will issue a daily projected spray plan to the Plans Unit, which will contain information for all phases of the day's spraying operation. The projections for a typical spray day, following the issuance of a daily spray plan, can be described in the following manner for those personnel involved in the Dipel evaluation:

1. One Hour Before Sunrise

a. Application Team Leader (ATL)
   1. Checks radio communications
   2. Receives weather information from G.O.
   3. Determines if weather conditions are acceptable for application.
   4. Insures that temperature and viscosity measurements are made for all bulk tanks and batch trucks under his responsibility.
   5. Insures that heating procedures are initiated and notifies the Unit Operations Chief of viscosity change.
   6. Other duties.

b. Application Equipment Manager (AEM)
   1. Conducts visual appraisal of application aircraft for abnormalities
   2. Checks batch truck for abnormalities and leaks, insures that batch product is recirculated and measures batch temperature and viscosity.
   3. Initiates heating procedures, takes product sample and notifies tha ATL of viscosity change.
   4. Other duties.

c. Unit Operations Chief (UOC)
   1. Notifies Deputy Incidence Commander and Dipel Test Coordinator of viscosity change.

[illegible] Compound, and [illegible] temperature [illegible] indicate [illegible] procedures and notify [illegible] [illegible].

6. Viscosity – Permissible viscosity range is [illegible] cps + 5%. [illegible] tank of [illegible] material when the viscosity exceeds [illegible] cps. [illegible] procedures for batches with [illegible] higher [illegible] this level.

7. Visual appearance – Do not load [illegible] spray [illegible] if it appears [illegible] or separated into [illegible].

VI. [illegible] Operations

The operation unit will [illegible] daily [illegible] to the [illegible] which will contact [illegible] of the [illegible]. The [illegible] for [illegible] day, following the [illegible] of a daily [illegible], can be described [illegible] following [illegible]. [illegible] are [illegible] [illegible]:

[illegible]

a. Application [illegible] Loader (ALP)
   1. [illegible] communications
   2. [illegible] – [illegible]
   3. Determine [illegible] conditions [illegible] acceptable for [illegible]
   4. [illegible] that [illegible] and [illegible]
   5. [illegible] and [illegible] responsibility.
   [illegible] the [illegible] operations [illegible] of [illegible]
   6. [illegible]

Application [illegible] (ADM)
   1. [illegible] visual [illegible] of [illegible] aircraft for [illegible]
   2. [illegible] truck for [illegible], [illegible] that [illegible] temperature and [illegible].
   [illegible] heating, [illegible], [illegible] product sample and [illegible] viscosity [illegible].
   [illegible]

[illegible]

2. Other duties

2. During Spray Operations

a. ATL - At Heliport/Airstrip or in spray blocks.
b. AEM - At heliport/airstrip
   1. Reads meters and records pesticides loaded on each application aircraft.
   2. Records sujective rating of Dipel handling criteria during loading of aircraft.
   3. Records take-offs and landings of each application aircraft.
   4. Other duties.
c. Ground observer (GO)
   1. Positions himself to visually watch the spray operation.
   2. Records sujective rating of spraying.

3. After Spray Operations Are Over for the Day

a. ATL - Meets with application team to determine needs for the next day.
b. AEM -
   1. Calculates amounts of pesticide used that day by block and aircraft. Gives forms to ATL.
   2. Insures that all remaining insecticide in aircraft is unloaded to batch trucks and prepares all necessary paperwork.
   3. Other duties.
c. GO - Gives rating forms to ATL.

Table 1. Subjective evaluation of handling properties for Dipel 6L.

Category	Rating	Descriptive criteria
Pumping	Good	Flowrate is 75-100% of equipment rating
	Fair	Flowrate is 50-75% of equipment rating
	Poor	Flowrate is below 50% of equipment rating
Ther criteria to consider - appearance, shearing, time for pumping.		
Flowmeter Operation	Good	Consistently within +5% of calibrated rate.
	Fair	Consistently within +10% of calibrated rate.
	Poor	More than 15% of the calibrated rate.
Strainer	Good	No solids on screen, no reduction in flowrate, product runs easily off of the screen when held vertically.
	Fair	No solids, product clings to screen when held vertically, frequent cleaning needed to maintain flowrate.
	Poor	Solids or clumps of material in screen, screen thickly coated with product, screen must be removed to maintain flowrate.
Spraying	Good	More than 75% of spray droplets of similar size.
	Fair	About 50% of spray droplets of similar size.
	Poor	Less than 25% of spary droplets of similar size.
Other criteria to consider - Spray cloud behavior, visibility of spray cloud		

ENTOMOLOGICAL SUB-PLAN

This sub-plan includes the following:

*** DRAFT - 1 ***

Entomological Sub-Plan

1988 Western Spruce Budworm Special Project

Bruce B. Hostetler and Donald W. Scott

In 1988 two insecticide formulations will be evaluated during a western spruce budworm suppression project on lands managed by the Mt. Hood National Forest and the Warm Springs Indian Reservation. The formulations are: (1) Dipel 6L applied undiluted at 42.7 ounces/acre (16 BIU/acre) ; and (2) Thuricide 32LV applied undiluted at 64 ounces/acre (16 BIU/acre). Thuricide 32LV will be evaluated on three intensively sampled spray blocks in the Warm Springs Unit, and Dipel 6L will be evaluated on three spray blocks in the Barlow Unit. In addition, one untreated block adjacent to the Badger Creek Wilderness Area will be intensively sampled to help adjust the larval survival estimates in treated blocks for naturally occurring mortality.

This Entomological Plan describes the sampling methods which will be used to estimate population densities, time insecticide applications, and assess treatment effects. Each type of sampling will occur during specific phases of the Project. A diagram which shows the sequence of decisions to be made regarding type of sampling, timing of sampling, and release of spray blocks for treatment is shown in Appendix A. Making reference to this diagram as you read this plan should help you understand when the various types of sampling methods are used and how they affect the decision making process.

EARLY LARVAL DENSITY SAMPLING

Objective

Population sampling will be used early during the insect development to estimate an average population density over the three Special Project spray blocks to be evaluated in each the Barlow and Warm Springs Analysis Units. Data collected will be used to determine whether these population densities are above the standard which qualifies an area for insecticide treatment. These population density estimates are **not** intended to be used as a pre-treatment estimates which, when compared to post-treatment population densities, gives an estimate of population reduction.

Qualifying Standard

To qualify for treatment, the average budworm density over each set of three blocks must be at least 4 larvae per 45-cm (17.7-in) branch. If the one standard error bounds about the mean do not include the density of 4 larvae per branch, the Special Project blocks will qualify for treatment if the mean is greater than 4, and will not qualify if less than 4. If the one standard error bounds do include the density of 4 larvae per branch, the Incident Commander, with input from entomologists and others, will make the final decision as to whether or not the blocks will be treated. Following are several hypothetical mean population densities with their standard errors and the treatment decisions that should result:

MEAN DENSITY	STANDARD ERROR	MEAN + OR - STANDARD ERROR	INCLUDES MEAN OF 4	TREATMENT DECISION
7.5	1.3	6.2 - 8.8	NO	TREAT
3.0	0.9	2.1 - 3.9	NO	DO NOT TREAT
3.5	0.9	2.6 - 4.4	YES	MADE BY IC
4.7	0.7	4.0 - 5.4	YES	MADE BY IC
4.7	0.6	4.1 - 5.3	NO	TREAT

The above qualification criteria are to be used for making treatment decisions on each set of three blocks as a unit. These criteria are **not** to be used for making treatment decisions on a block by block basis.

Timing

Because timing of the insecticide application will be critical due to the narrow Effective Spray Interval, sampling will be scheduled to qualify Special Project spray blocks as early as possible. Sampling will commence at the beginning of budburst (i.e., when needles are clearly visible through an opening in the bud scales) when most larvae are in third- and fourth-instars. This may be as early as the first or second week of May.

Sampling Plan and Procedure

At least 13 Early Larval Density Plots will be distributed throughout each of the six Special Project blocks that will be treated. These plots will be located at the same sites as 13 of the 25 Pre- and Post-treatment Evaluation Plots. Early Larval Density Plots will be located at the same sites as the Evaluation Plots, with at least 40 Early Larval Density Plots established in each set of three treated Special Project blocks. This will provide a good representation of densities occurring within the these treated blocks. Selection of the Early Larval Density and Evaluation Plot sites will begin as soon as the entomologists and the entomology crews report to the project.

The sample trees at each plot will consist of three Douglas-firs or three true firs. The trees will be open-grown with bud-bearing branches in the mid-crown, 20 to 30 ft. tall, and exposed to full sun most of the day. In mixed stands, sample trees will be selected from the predominant host species. **Do not sample the same trees that will be sampled on the Evaluation Plots.**

One 45-cm (17.7-in) apical or outside branch will be obtained from the mid-crown of each of the three sample trees on each plot. Each branch will be clipped with a pole pruner and collected in the cloth collecting basket attached just below the cutting head. Branches will not be trimmed if they are longer than 45-cm, nor discarded if they are shorter. Extra branches will be taken only if a sampled branch has no live buds. Each branch plus any larvae that have fallen into the basket will be placed into a paper bag. All sample information will be recorded, using a pen with waterproof ink, on each bag on the Field Collection Data Form (Biological Form No. 1, see Appendix B) which previously has been stamped on the outside of the bag. The top of the bag will be folded over twice and stapled shut to prevent escape of larvae. The three bags from each sampling location (plot) will then be stapled or bundled together, placed in a cardboard box labeled on the outside, and transported to the laboratory. If the Special Project areas within an Analysis Unit

marginally meets the qualification standard and it is thought that all overwintering larvae have not yet dispersed to the new buds, the plots should be sampled again in 3 or 4 days (or sooner if weather is particularly warm and dry).

Sample Processing

At the laboratory, samples will be put into a walk-in cooler at 40°F until they can be examined. Each sample will be examined within 24 hours after collection. All budworm larvae will be collected, including those within unopened buds and those which have fallen or crawled off the branch and remained in the paper bag. The bag should be cut open and taken apart since some larvae crawl into the folds. Also, the old needles should be checked for mining larvae. A petri dish will be labeled for each branch sample, and all larvae from that branch placed into a petri dish containing in 95-percent alcohol. Western spruce budworm larvae will be separated from larvae of other species by an entomologist or other qualified person. The numbers of buds, budworm larvae, and other Lepidoptera larvae will be recorded for each plot on the Early Larval Density Data Sheet (yellow copy of Biological Form No. 2, see Appendix B). This data will be used to estimate early instar larval densities for the Analysis Units.

If a unit is borderline for qualification, more density estimate samples will be taken from the unit to help in making a decision. If it is felt that the larvae had not all dispersed to the new buds when the first samples were taken, the same plot sites should be sampled again and a new density calculated using the new sample data only. If the larvae had already dispersed at the time of the first sampling, additional samples should be taken at the previously unsampled Evaluation Plot sites and these data pooled with the initial sampling data to calculate the average population density for the Special Project spray blocks.

The recommendation for treating, or not treating, the Special Project areas will be transmitted in writing by the Entomology Section Chief to the Incident Commander via U.S. Department of Agriculture Form AD-311 (Speed Memo).

Automated Data Processing (ADP) Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the project.

If the Data General system is used, information from the Early Larval Density Data Sheet will be entered into the database "EDENSITY" using the Forms Entry System (FES). Data must be entered the same day as samples are processed. Data collected for each project area will be entered only in the database established for that project. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	EDENSITY	138
WARM SPRINGS (special)	WARM_SPRINGS_S	EDENSITY	148

The database is maintained as a multiple record data file and is used in conjunction with the Western Budworm Decision Support System (WESTBUDS). The program will be accessed through the Ft. Collins Computer Center (FCCC) and run either interactively or by batch process. Details for accessing and running WESTBUDS are covered in Appendix C. Since we desire to qualify Analysis Units as early in the Project as possible, timeliness of data entry and processing is essential to management of the Project. Accordingly, plot data should be entered promptly and the data set records transferred to FCCC daily to provide up-to-date information. The program should be run each day after updating the data set, to obtain the current status of early larval densities over the Analysis Unit.

LARVAL DEVELOPMENT SAMPLING

Objective

The efficacy of the B.t. treatment depends, to a great extent, upon applying the correct dosage at the proper time. The objective of the larval development sampling is to determine when to apply B.t. to each spray block so that the probability of larval mortality will be greatest. Spray blocks will be "released" for treatment when development sampling results indicate that budworm have obtained the optimal stage for treatment with B.t.

Release Criteria

When during the course of periodically sampling for budworm development it is determined 95 percent of all buds have unfurled (i.e., the budcap is gone, the bud sheath is broken, the shoot has elongated, and the needles are no longer bunched) and less than 15 percent of the budworm larvae are in 2nd and 3rd instars combined, the spray block will be released for treatment. If any live budworm pupae are found in the samples, the entire block will be released immediately. If poor weather or operational problems result in delaying treatment and 5 percent or more of budworm within a block have pupated that block will be excluded from treatment.

Releasing of Blocks for Insecticide Treatment

The entomologist in charge will release each block for treatment on the date and time it is determined that the release criteria have been met. Each block released is to be treated within 72 hours after the time of release.

All notifications of release of blocks for treatment will be made by the entomologist in charge to the Incident Commander in writing on the Treatment Block Release Form (green copy of Biological Form No. 3, Appendix B).

Timing

Larval development sampling may begin as early as the second week of May. Development plot sites will be identified as soon as entomologists and crews arrive on the project and will be visited intermittently until the first buds begin to burst. At this time, plots will be sampled at least twice weekly until buds open and the foliage begins to expand. Depending on weather and rate of development, samples will then be taken as often as necessary and will continue until Release Criteria (i.e., less than 15 percent in 2nd plus 3rd instars and 95 percent of buds unfurled) are met for the block and the block is released for treatment.

Sampling Plan and Procedure

The sequence of insecticide treatment of spray blocks will depend upon the progression of larval development within each block. Block boundaries will be selected such that the difference in aspect and elevation will be minimized within each block. The elevation change within a block should be no greater than 1,000 feet. This will help to lower differences in larval development and host phenological development within each block.

Larval development samples will be collected from at least half of the 25 Early Larval Density and Evaluation Plot sites within each of the six treated and the one untreated blocks. These sampling sites will be located such that they best characterize the range of both elevational and aspect differences within each block. **Development samples will not be taken from Evaluation Plot trees**.

A Development Plot Location Data Sheet (pink copy of Biological Form No. 5A; see Appendix B) will be completed for each plot. All sample plot locations will be identified on a master District Transportation map. Pink-glo, green-glo, and red flagging together will be used to mark each plot site along the road.

At each of the development plots one branch will be clipped from the lower crown of each of 4 trees. The same 4 trees may be, but are not required to be, sampled in subsequent visits to the same plot. Sample trees must conform to the same criteria established for the Early Larval Density Sampling described in the previous section, but will be sampled in a different manner. Sample trees selected for development sampling must have abundant foliage with newly developing shoots in the lower crown, which can be reached from the ground without the aid of a pole pruner. In stands with only one host species, all 4 sample trees will be of that species. In a mixed species stand it is especially important in a development sample that both host species (i.e., Douglas-fir and true fir) are represented, since development rates may differ among host species that occur at the same location (Williams et al. 1985). Thus, in mixed species stands, 2 sample trees will be one host species and two the other. One exception to this is when only a few true firs occur at elevations or slopes dominated by Douglas-fir. In this situation, only Douglas-fir should be sampled.

Samples will be obtained by clipping one 45-cm apical branch tip with developing shoots from the lower crown of each sample tree. Care must be exercised to minimize the disturbance of the neighboring branches on the sample tree, as they may be sampled during future visits to the plot during the

development sampling. Disturbing these branches may cause large larvae to spin down from the branch with the resultant sample from that branch being biased towards less mobile earlier instars.

After each sample branch is clipped, the first step is to process the branch through a beating box. Next, tally all unfurled shoots as well as the total number of new shoots or buds, and then examine all larvae that fall onto the drop cloth as well as those which remain on or in the buds or shoots. All larvae will be tallied, and instar determinations will be made for western spruce budworm larvae. If any live budworm pupae are found at any point in the sampling of any development plot, sampling will cease within that spray block and the information will be relayed immediately to the laboratory so that the block can be released for treatment. All budworm pupae found will be brought back to the laboratory for verification by an entomologist. If there is any doubt as to the collectors' abilities to distinguish budworm larvae from other larvae and/or to determine budworm larval instars, especially in the first several collections that a crew makes, all larvae from each branch should be placed into a tight-lid petri dish or vial, labeled (Analysis Unit, block, plot, tree species, date, etc.), and brought back to the laboratory for examination by an entomologist or other qualified person.

At least 25 budworm larvae will be collected at each development plot. If a total of at least 25 larvae is not obtained from the 4 sample branches, keep sampling and processing (as described above) branches one at a time, alternating host species, until this is achieved.

> **NOTE:** ALL larvae from the first 4 branches will be tallied, even if the total number of budworm larvae is greater than 25. If extra branches are needed, ALL larvae will be tallied from each branch sampled (i.e., don't quit looking when you reach a total of 25 budworm larvae).

Tree species, total number of shoots, number of shoots that have unfurled, number of budworm larvae in each instar, total number of budworm larvae, and total number of other lepidopterous (moth and butterfly) larvae will be recorded for each branch tip on the Budworm Development Plot Data Sheet (white copy of Biological Form No. 4) for ADP entry. After all development plots within a spray block have been sampled, the crew will relay this information to the laboratory by radio. An entomologist or an assistant will graph the data to illustrate the percentage of larvae in the 2nd plus 3rd instars in each spray block.

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the project.

If the Data General system is used, information from the Larval Development Plot Data Sheet will be entered into the Data General database "DEVELOP" using

the Forms Entry System (FES). Data must be entered the same day as samples are processed. Data collected for each project area will be entered only in the database established for that project. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	DEVELOP	138
WARM SPRINGS (special)	WARM_SPRINGS_S	DEVELOP	148

As with the Early Larval Density database, the Development database is maintained as a multiple record data file and is used in conjunction with WESTBUDS. It is different in that the analysis programs in the DEVELOP module can be run on the Data General system when access to the Fort Collins Computer Center is not available. The larval development data are used to generate a report within the Data General system which will display:

(1) percent of unfurled shoots and proportion of larvae in the 2nd plus 3rd instars for each spray block;

(2) spray blocks which meet the insect development criterion for treatment, but not necessarily the foliage development criterion for treatment;

(3) spray blocks which must be released for treatment immediately since at least one pupa was observed in the development samples; and

(4) spray blocks which should not be treated due to the advanced development of the insect (i.e., greater than or equal to 5 percent pupae).

To obtain current development information on the spray blocks, the program should be run for each spray block as soon as the development data have been entered into the dataset.

Procedures for entering, processing, and analyzing data are outlined in Appendix C.

PRE-TREATMENT SAMPLING

Objective

The purpose of the pre-spray sampling is to determine budworm population densities and instar distributions for each Special Project spray block at the time of treatment. These densities, when compared to post-treatment density, will be used to estimate budworm population reductions.

Timing

Pre-treatment samples will be collected after a spray block designated for treatment has been released and within the 48-hour period before treatment. If any of the 25 Pre-treatment Evaluation Plots are not treated within the 48 hour

period after sampling, Pre-treatment samples will be collected again from the untreated plot trees. "Pre-treatment" samples will be collected in the untreated block as soon as it is determined that larval development has met the requirements for "release".

Sampling Plan and Procedure

Twenty-five Evaluation Plots, from which both Pre- and Post-treatment samples will be collected, will be established within each of the seven Special Project blocks (six treated and one untreated). Each Evaluation Plot will be located at least one quarter mile for the nearest block boundary, and at least 100 feet from the nearest road. An Evaluation Plot Location Data Sheet (blue copy of Biological Form No. 5B; see Appendix B) will be completed for each plot. All sample plot locations will be identified on a master District Transportation map. Pink-glo and green-glo flagging together will be used to mark each plot site along the road and along a trail going to the plot sample trees. Three sample trees for mid-crown sampling will be selected and each will be marked with one pink-glo and one green-glo ribbon tied around the bole and another pair of ribbons, along with a white tag showing the plot and tree number, secured to a branch tip no lower than head high. It is important that accurate maps and directions to the plots are included on the Evaluation Plot Location Data Sheet so that both entomological sampling crews and spray deposit assessment crews can find the plots easily.

Evaluation Plot sample trees will be selected using the following criteria:

(1) species will be the same as the predominate host type in the surrounding stand;

(2) must contain current-year shoots (new shoots) in the mid-crown;

(3) must be reasonably open-grown and exposed to full sun most of the day; and,

(4) must be 20 to 30 feet tall so they can be sampled at mid-crown using a pole pruner.

The sample trees on each plot will be located within a 1-acre area. Widely scattered, open-grown host trees beneath a non-host overstory should not be selected as sample trees.

Two apical, 45-cm branch tips will be clipped from opposite sides (i.e., one from each side) of the mid-crown of each of the three sample trees using a pole pruner equipped with a collecting basket. Each branch must have at least six new shoots. To help insure that population density estimates are reliable and unbiased, the following precautions must be taken:

(1) Do not disturb branches other than the one being collected so as to avoid having larvae from these branches drop into the collecting basket.

(2) If other branches are accidentally disturbed, all budworm larvae must be removed from the basket and another sample branch clipped.

(3) Do not disturb the sample branch with the pole pruner until the collecting basket is situated below the branch. This will help insure that larvae which fall off the branch during the clipping procedure are collected in the basket.

Accuracy of these data is crucial since they provide the pre-treatment budworm densities with which post-treatment densities will be compared to measure budworm population reduction on the Special Project treatment areas. These measurements provide the basis for conclusions regarding the efficacy of the B.t. treatments.

Sample Processing

Processing of pre-treatment samples will be done in the field at time of collection. After being clipped, each branch sample plus the contents of the collecting basket will be carefully removed and placed into a beating box on top of a white drop cloth. A visual inspection of the basket will be made to insure that all larvae have been dislodged. First, all new shoots on the branch will be counted and the number recorded. Then, the branch will be processed through the beating box by vigorously rapping the branch on the inside walls of the box. The rapping should not be so hard as to injure the larvae, however. The branch should be visually inspected for any remaining budworm. Processing the sample in a shaded location should help to minimize larval activity, thus, reducing the probability that larvae will crawl off the drop cloth before they can be counted. Numbers of budworm larvae in each instar, other lepidopterous larvae, and new shoots will be counted and recorded on the Pre-Treatment Evaluation Plot Data Sheet (buff colored copy of Biological Form No. 12; see Appendix B).

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the project.

If the Data General system is used, information from the Pre-Treatment Evaluation Plot Data Sheet will be entered into the database "PREDENS" using the Forms Entry System (FES). Data must be entered the same day as samples are processed. Data collected for each project area will be entered only in the database established for that project. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	PREDENS	138
WARM SPRINGS (special)	WARM_SPRINGS_S	PREDENS	148

The database is maintained as a multiple record data file and is used in conjunction with the Western Budworm Decision Support System (WESTBUDS). The program will be accessed through the Ft. Collins Computer Center (FCCC) and run either interactively or by batch process. Details for accessing and running WESTBUDS are covered in Appendix C. Since we desire to qualify Analysis Units as early in the Project as possible, timeliness of data entry and processing is essential to management of the Project. Accordingly, plot data should be entered promptly and the data set records transferred to FCCC daily to provide up-to-date information. The program should be run each day after updating the data set, to obtain the current status of early larval densities over the Analysis Unit.

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General (DG) system.

FOLIAGE DEPOSIT ASSESSMENT SAMPLING

Objective

Sampling of foliage recently treated with B.t. will be done to measure the insecticide deposits on the target site and to correlate those deposits with measurements of efficacy (i.e., larval mortality, population reduction, and defoliation).

Since the foliage deposit assessment will be done by a private contractor, the details of the procedures are described in the contractor's proposal (see Appendix D), and will not be repeated here.

Timing

Entomological crews will begin sampling evaluation plot trees no sooner than one hour after insecticide application has been completed for the day in the spray block. This will allow time for the small insecticide droplets to settle and for partial drying of deposits on foliage to occur.

Sampling Plan and Procedure

Samples will be collected from the mid-crown of evaluation plot trees on the Special Project spray blocks that have been treated. Crews will obtain 45-cm branch tips on each treated Pilot Test block upon completion of B.t. application over the twenty-five 3-tree clusters of evaluation plot trees.

Samples will be collected from 60 of the 75 sample trees on each Special Project block which has been treated (i.e., 25 plots/block x 3 trees/plot = 75

trees/block). Two 45-cm, mid-crown branch tips (one each from opposite sides) will be collected from each of the three sample trees on the first 20 Evaluation Plots of each treated Special Project block to obtain the 60 mid-crown branch samples required for foliage deposit assessment. Collections will be made using a pole pruner with an attached cloth collecting basket. When clipping the branches, crews must take care not to disturb neighboring branches. This will cause larvae to drop from branches which, in turn, may bias post-treatment density estimates. After clipping the sample, the branch should be carefully removed from the cloth basket, handling it by the cut-end **only**. The branch should be inspected to be sure that it contains between 18-24 new elongating shoots. Foliage deposit assessment requires only eight new shoots per branch; however, the extra foliage will be used to conduct a laboratory foliage-feeding bioassay (see next section for details).

The foliage deposit assessment contractor will remove or will give crews instructions for removing and handling of 4 new shoots from each of the two sample branches. The two branches from each tree will be placed into one paper bag. All sample information will be recorded, using a pen with waterproof ink, on the Field Collection Data Form (Biological Form No. 1; see Appendix B) which has been stamped on the bag. In addition to the information asked for, the time of collection (use 24-hour clock) will be written at the top of the form. The top of the bag will be folded over and stapled shut to contain the sample. It is not necessary to collect or account for any of the larvae.

Foliage samples will be placed in portable coolers containing "blue ice" as soon as they are bagged, and returned to the Unit Laboratory after collection from all designated sample trees is complete. All samples which have been brought back to the Barlow and Warm Springs Unit laboratories will be transported the same day of collection to the Foliage Deposit Assessment Laboratory in Pendleton, Oregon. Once there, samples will be stored in a walk-in cooler until ready to use in the foliage-feeding bioassay.

FOLIAGE-FEEDING BIOASSAY

Objective

The purpose of the foliage-feeding bioassay is to determine whether the insecticide deposited on the foliage contains enough active crystal endotoxin to cause budworm mortality.

Timing

Branch tips will be collected starting about one hour after insecticide application has been completed for the day in the spray block. This will allow time for the finely atomized spray deposits to settle on the foliage target, and for partial drying of the insecticide deposits. These samples will be the same branch tips from which foliage was taken for foliage deposit assessment.

Sampling Plan and Procedure

The branch tips collected from each treated Special Project block and used for foliage deposit assessment will also be used for the foliage-feeding bioassay. The details of the sampling and handling of these branch samples is described

in the previous section. No samples will be collected from the untreated block.

The Entomology Laboratory Section Leader in the Pendleton laboratory with be provided with remaining portions of all branch samples from which the deposit assessment sub-samples were obtained. Also, any additional branch samples collected specifically to provide foliage for the bioassay will be turned over to the Entomology Lab Section for processing.

A random selection of 25 of the 60 bags (each containing two 45-cm branch tips) will be made by the Entomology Laboratory Section Leader. These samples will be bioassayed for activity of B.t. deposits with western spruce budworm larvae. The samples will be inventoried and placed in a walk-in cooler at 40°F, until they can be processed. All samples will be processed the same day as collected to insure samples are used while foliage is still succulent and palatable to the budworm larvae.

Sample Processing

Laboratory protocol

Laboratory personnel will follow rigid protocol for handling and processing foliage samples, and in conducting the laboratory feeding bioassay. This will help avoid cross-contamination of samples treated with different products, or not treated at all. Only individuals assigned to work in the laboratory will be permitted in the bioassay and rearing rooms. Field-going personnel may not go into these labs unless approved by the Project Entomologist. Sterile techniques appropriate to the work will be used during all stages of handling and processing foliage, handling laboratory-reared bioassay larvae, and setting up the bioassay.

The laboratory colony of budworm will be maintained in a separate room or in a temporary isolation area of the bioassay room to avoid contaminating the colony with B.t. Sterile technique will be closely followed in the rearing of the lab colony. An ultra-violet germicidal lamp will be used for one hour each evening (using an electric timer to turn fixture on and off automatically), to sterilize the rearing area.

Laboratory personnel will wash hands thoroughly with soap and warm water, and will don appropriate laboratory apparel before beginning work in the lab. Floors, tables, countertops, other work surfaces, sinks, plumbing fixtures, and any equipment used in the bioassay work will be wiped with a quaternary ammonium chloride disinfectant and allowed to air dry before beginning. Any instruments used such as scissors, clippers, forceps, etc., will be soaked overnight in disinfectant solutions. Instruments will be soaked intermittently in disinfectants while work is in progress.

Clean white waxed paper will be placed on work surfaces prior to starting to work. Priority for processing will always be to process foliage samples and set up bioassay on the untreated control plots first, before proceding with B.t.-treated plots. End-of-day cleanup will involve repeating the procedures described in the foregoing. In addition, floors will be swept and mopped with a quaternary ammonium chloride disinfectant. All garbage will be removed from the rooms and properly disposed of before leaving for the day.

Rearing bioassay larvae

Small tight-lid plastic petri dishes containing a disease-free diapausing strain of western spruce budworm larvae will be kept under refrigeration at about 38-40°F until set up for rearing. Dishes of larvae will be removed from refrigeration to begin rearing for bioassay approximately 10 days before first anticipated application date on a Pilot or Special Project Test block. Dishes will be brought out and set up each day thereafter to provide adequate numbers of larvae for conducting a daily bioassay. Since it will be difficult to know beforehand how many dishes of diapausing larvae will be needed each day, the dishes removed per day will be evenly distributed across the anticipated number of spray days, so as to provide an uninterrupted supply of larvae for bioassay. This schedule will include the needs of the Barlow/Warm Springs Special Project, as well as those of the Meacham Pilot Project. The diapausing larvae will be set up for rearing by placing an opened petri dish of larvae into a rearing cup (7 ounce specimen container) containing 6 to 8 1-inch squares of budworm rearing medium. Diet should be handled only with a disinfected spatula. A cardboard lid will be inserted into the top of the cup and the outside of the cup labeled with the set-up date, using a pen with waterproof ink. The tiny budworm larvae will become active in a few hours and begin feeding on the rearing medium. Larvae will not require refeeding during the time they are being reared.

Each morning, larvae from the laboratory culture will be checked beginning with the 7th or 8th day of incubation, and any 4th-instar larvae that are found will be removed and placed in a plastic petri dish (Falcon 1029) without artificial diet, and labeled with the date larvae were collected. Butterfly forceps will be used to transfer larvae in order to avoid injurying them. The development time for western spruce budworm larvae to reach the 4th instar when reared at temperatures of 73 to 77°F, is 12 days from termination of diapause. Larvae will be removed from the rearing cups and placed in the petri dishes to provide the numbers required for setting up the day's bioassay samples, plus some extra for a contingency. Entrance to the rearing room or rearing area of the bioassay room should be limited to this one-time occurrance each day. Once these larvae are removed from the rearing room, they may not be returned to the rearing room under any circumstances. Any unused bioassay larvae remaining at the end of the day will be saved for use the following morning. The "left-over" larvae should be used up first thing in the morning, before starting on freshly-collected bioassay larvae. Any larvae that have developed beyond the 4th instar should not be used for the bioassay. These larvae will be properly disposed of.

Bioassay procedure

The larvae used in the bioassay of foliage should all be in the same (4th) instar. Extra larvae will be required to insure enough are available for bioassay of foliage collected from the Meacham Pilot Test blocks and from the Mt. Hood Special Project blocks, as well. Larvae for the bioassay will be provided by PNW RWU-4502.

The bioassay design will be based on the following:

Forest	Number of Blocks Sampled for Bioassay	Total

Project	Control	Dipel 6AF	Thuricide 48LV	Dipel 6L	Thuricide 32LV	
Umatilla						
Meacham	1	3	3			7
Mt. Hood						
Barlow				3		3
Warm Springs					3	3
Totals	1	3	3	3	3	13

13 Blocks (7 on Meacham; 3 on Barlow; and 3 on Warm Springs)
x 25 Branches per Block
325 Branch Samples (1 branch sample per bioassay cup)
x 10 Western Spruce Budworm Larvae per Branch
3,250 Larvae (4th instar) for Bioassay

For every 10 4th-instar larvae to be available for each bioassay cup, 17 to 23 larvae will be required because of polymorphic development and probable loss from transfer and natural mortality, of budworm larvae. The total number of larvae required, therefore, will be:

5,525 to 7,475 Larvae (325 x 17 and 325 x 23)

The foliage-feeding bioassay will be set up in 7 ounce specimen containers. Each of 25 containers will be labeled on the outside using a pen with waterproof ink. Information recorded on the container will include AU number, block number, plot number, branch number, and date bioassay was set up.

Each of the 25 randomly selected branches from the Pilot Test and Special Project blocks will have 10-16 new shoots removed, by clipping with scissors or hand clippers. Scissors and hand clippers used for processing foliage samples, as well as forceps, will be alternated with freshly disinfected instruments after processing each branch sample. New shoots removed from the branch will be placed in the pre-labeled bioassay cup (i.e., 7 ounce specimen container).

Each cup will be infested with 10 4th-instar laboratory-reared budworm. Larvae will be taken from the supply of bioassay stock which were put into plastic petri dishes the first thing that morning. Since the number of branch samples that can be set up for bioassay each day is dependent upon the supply of larvae, the bioassay samples will be set up as larvae are available each day. Every effort will be made to insure that sufficient larvae are available each day to infest the bioassay cups the same day as treated. Because budworm larvae are polymorphic in development, some larvae will be too young to use and others too old; hence, there may be times when enough larvae are not available to complete the bioassay of all samples collected the day of treatment. In these instances, the uncompleted samples will be given priority for setting up the following day when more 4th instar larvae will be available.

Larvae will be transferred from the petri dishes to the bioassay cups using butterfly forceps. Care must be taken in handling larvae to avoid injuring them. Injured larvae should not be used in the bioassay. Clean (disinfected) forceps should be used to transfer larvae. Used forceps will be exchanged with

disinfected forceps from the instrument tray after the three branch samples from an evaluation plot have been infested with larvae.

The cardboard lid will be inserted into the top of the bioassay cup after infesting the cup with larvae. Cups will be placed on a rearing rack and incubated at room temperature for 7 days. The bioassay results of each cup will be read on the seventh day of incubation. A clean sheet of white waxed paper will be placed on the table and the contents of a bioassay cup will be dumped onto the paper. The total number of budworm larvae placed in the cup and the number of dead larvae will be recorded on the white copy of the Foliage Bioassay Data Sheet (Biological Form No. 14; see Appendix B). The person reading the bioassay results should enter his or her name on the Data Sheet in the column marked "NAME OF EXAMINER -- COUNTS". Each dead larva will be placed on a microscope slide and a squash preparation made for microscopic examination. A trained examiner will check each larva under a phase contrast microscope to determine the presence of B.t. The total number of larvae with B.t. from each bioassay cup will be recorded on the Foliage Bioassay Data Sheet for entry into the computer. The person making the microscopic examination should enter his or her name on the Data Sheet in the column marked "NAME OF EXAMINER -- DIAGNOSIS".

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General (DG) system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the Project.

If the DG system is used, bioassay results will be entered into the Data General database "BIOASSAY," using FES. Data should be entered the same day as collected and sent to FCCC daily to keep data files current. Only the Special Project block data will be entered into this database. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	BIOASSAY	138
WARM SPRINGS (special)	WARM_SPRINGS_S	BIOASSAY	148

POST-TREATMENT BUDWORM DENSITY SAMPLING

Objective

The purpose of this sample is to determine the post-treatment residual population densities for each of the seven Special Project spray blocks and to compare them with the targeted level. This will help evaluate the short-term success of the B.t. application in reducing populations of western spruce

budworm. Post-treatment densities also will be compared with pre-spray densities to estimate population reduction percentages.

Population Reduction Standard

The population density standard against which the mean population density for each Special Project spray block will be compared is one western spruce budworm per 45-cm branch tip.

Timing

Post-treatment density samples will be collected from each treated Evaluation Plot no sooner than 14 days after treatment, but after pupae are first detected in the spray block. Sampling will be done no later than 21 days after treatment, even if no pupae have been detected in the block by that date. "Post-treatment" samples will be collected in the untreated block when the first pupa is detected or 21 days after the "pre-treatment" samples were collected.

Sampling Plan and Procedure

Post-treatment samples will be collected from the same plots and trees as the pre-treatment samples using the same procedures.

Each sample tree on each of the 25 Evaluation Plots in each Special Project block will be sampled at the mid-crown with pole pruner and basket, in the conventional manner. Four 45-cm mid-crown branch tips will be collected from each tree. These samples should be obtained from different locations around the crown, but care should be taken to avoid sampling branches adjacent to those which had tips removed during pre-spray or foliage deposit assessment sampling.

All live budworm larvae, pupae, and any pupal exuviae (the empty pupal case that remains after a moth emerges), will be collected and placed individually (except for exuviae) in plastic tight-lid petri dishes and taken to the laboratory for rearing.

Accuracy of these data is crucial since it will be used for analysis and evaluation of treatment results.

Sample Processing

Processing of the Post-treatment evaluation sample will be done in the field at time of collection. After being clipped, each branch sample plus the contents of the collecting basket will be carefully removed and placed into a beating box on top of a white drop cloth. A visual inspection of the basket will be made to insure that all larvae have been dislodged. First, all new shoots on the branch will be counted and the number recorded. Then, the branch will be processed through the beating box. Processing the sample in a shaded location should help to minimize larval activity, thus, reducing the probability that larvae will crawl off the drop cloth before they can be counted. All larvae, pupae, and pupal exuviae (the case remaining after an adult has emerged) will be counted and collected for rearing (larvae and pupae) or examination (exuviae) by an entomologist. Branch samples will be vigorously rapped against

the inside walls of the beating box to dislodge larvae onto the drop cloth. The branch then will be carefully inspected for remaining larvae, pupae, or exuviae. Living larvae and pupae collected from either the branch or the drop cloth will be placed individually into plastic petri dishes. Each dish will be labeled, using a printed self-adhesive label (Biological Form No. 17, see Appendix B), with collection date and Analysis Unit, spray block, plot, and tree numbers.

In the same manner, pupal exuviae will be placed together in a petri dish and labeled appropriately. All petri dishes from the sample should be placed together in a small paper sack for return to the lab, and the sack labeled with the post-treatment interval collection date, spray block, and plot number. Information will be recorded on the green-colored Post-Treatment Evaluation Plot Data Sheet (green copy of Biological Form No. 13; Appendix B). It is imperative to keep the sack containing budworm collections out of the direct sun to avoid thermal death of the larvae or pupae. Do not leave samples in a vehicle parked in the sun while another plot is being sampled. Samples should be placed in the styrofoam cooler containing "blue ice" for transport back to the laboratory.

Laboratory Rearing of Post-Treatment Budworm Collections

For a number of reasons, not all budworm larvae will have died by the time the post-treatment evaluation is conducted at the beginning of pupation. However, some of these larvae (as well as pupae) may be infected with B.t. and, in time, will die. If such is the case, an estimate of post-treatment population densities at these times would be premature. Rearing larvae and pupae until either death or adult emergence occurs would determine how many more individuals per branch will die if allowed sufficient time; thereby, more accurately reflecting treatment efficacy. All live western spruce budworm larvae and pupae counted on the first two branches collected from each plot tree during the post-treatment sampling will be collected and reared for all treated Special Project blocks. For the untreated block, all live budworm larvae and pupae will be collected and reared from only the first branch collected from each plot tree. In total, all live budworm larvae and pupae from 900 treated branches and from 25 untreated branches will be collected and reared.

To rear the larvae, fresh artificial budworm medium will be provided to larvae in each dish. Larvae and pupae should be checked daily to determine the need to refeed larvae and detect mortality that may have occurred since the previous inspection was made. Larvae that die and pupae which have not transformed into adults after 14 days in the pupal stage will be collected and any remaining diet removed from the dish. After recording, the dead larvae and pupae will be sent to Forest Pest Management in the Regional Office for further assessment. Results of rearing these field-collected budworm will be recorded on the Budworm Rearing Form (Biological Form No. 7, see Appendix B).

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General (DG) system.

[illegible] Fig. [illegible]
[illegible] translating [illegible]
[illegible] plastic petri dishes. Each [illegible]
[illegible] Level (Biological Form [illegible]
[illegible] Analysis [illegible]

[illegible] will be placed together in a petri dish [illegible]
[illegible] the same [illegible]
[illegible] the lab, and the [illegible]
[illegible] collection date, [illegible]
[illegible] Biological Form [illegible]
[illegible] the larvae or pupae. [illegible]
[illegible] while another plot is being [illegible]
[illegible] the container containing [illegible]

[illegible] Post-Treatment Budworm Collection

[illegible] number of [illegible], our all budworm larvae will [illegible]
[illegible] of these [illegible] may be [illegible]
[illegible] such is the case [illegible]
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[illegible] will be provided to larvae
[illegible]
[illegible] pupae which have not [illegible]
[illegible] will be collected and [illegible] remaining
[illegible] Regional Office for further assessment.
[illegible]

[illegible]

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the Project.

If the DG system is used, post-treatment density data will be entered from Biological Form No. 13 into the Data General database "POSTDENS" using FES. Data should be entered the same day as collected and sent to FCCC daily, to keep data files current. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	POSTDENS	138
WARM SPRINGS (special)	WARM_SPRINGS_S	POSTDENS	148

The multiple record data files LDENSITY and POSTDENS provide input to run the WESTBUDS system module that displays the post-treatment larval, pupal, and adult moth densities on a 45-cm branch basis. This information will provide the final measure of treatment efficacy for each project location. Details for accessing and running WESTBUDS to summarize the post-treatment densities are covered in Appendix C.

Budworm rearing data will be entered into the database "EREAR," and analyzed using WESTBUDS. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	EREAR	138
WARM SPRINGS (special)	WARM_SPRINGS_S	EREAR	148

Running the EREAR module in WESTBUDS analyzes the post-treatment budworm rearing data with the multiple-stage sampling program. The program computes means and standard errors for total budworm reared, parasitized budworm, emerging adult budworm, and unspecified budworm mortality, on a 45-cm branch basis.

ADULT PHEROMONE TRAPPING

Objective

Pheromone traps will be used in the Special Project blocks to provide another measure of post-treatment population levels and to predict budworm defoliation the year following treatment.

3. [illegible] assumptions and [illegible]
   [illegible] [illegible] system to [illegible]
   [illegible] [illegible] will be [illegible]

[illegible] used. [illegible] data will be entered from
[illegible] the [illegible] database [illegible] date, [illegible]
[illegible] created the same day as collected and sent to FCOC daily, to
[illegible] counts. Projects, drawers, folders, and Analyte's Unit numbers

[illegible]	[illegible]	[illegible]	AL [illegible]
[illegible] (special)	[illegible]	[illegible]	[illegible]
[illegible] (special)	[illegible]	[illegible]	[illegible]

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[illegible] saving [illegible] that displays the [illegible] [illegible] [illegible], [illegible]
[illegible] moisture [illegible] on a [illegible]-mm branch [illegible]. This information will produce
[illegible] (list) [illegible] of treatment efficacy for each [illegible] location. Results for
[illegible] [illegible] [illegible] using [illegible] to summarize the [illegible]-treatment densities, are
[illegible] in Anaheim CA.

[illegible] entering data will be entered into the database "[illegible]," and analyzed
[illegible] projects. Projects, drawers, folders, and Analyte Unit numbers are

[illegible]	[illegible]	[illegible]	AC [illegible]
[illegible] (special)	[illegible]	[illegible]	[illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible] the [illegible]-treatment [illegible]
[illegible] [illegible] the program's [illegible]
[illegible] [illegible], [illegible]

[illegible] [illegible] to [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible]

Timing

Pheromone traps will be placed in the field at the same time that post-treatment samples are collected, probably around the middle of July.

Sampling Plan and Procedure

One trap will be placed at each of 13 Evaluation Plot sites in each of the seven Special Project blocks. Each trap will be hung on the end of a lower crown branch, at head-height or higher, of an open-grown host tree. Traps will be hung perpendicular to the branch axis, near the end of the branch, so as not to block the trap entrance. The wire ties will be looped and crossed over the top of the branch, brought back under the branch and twisted together to secure the top of the trap tightly to the underside of the branch. This will prevent the trap from slipping off the branch, especially during windy conditions.

Traps will be of the delta sticky trap type and will be baited with a 92:8 mixture of the principle components of the naturally occurring western spruce budworm pheromone (E-11 and Z-11 tetradecenal) at a strength of 0.0001 percent by weight in a PVC pellet. Traps will be left without servicing through moth flight and retrieved as soon as possible after moth flight, preferably by the first week of September. Numbers of budworm moths will be counted and recorded for each trap. Data will be recorded on the Budworm Pheromone Trapping Form (pink copy of Biological Form No. 8, see Appendix B).

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General (DG) system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the Project.

If the DG system is used, western spruce budworm moth trapping data from Biological Form No. 8 will be entered into the DG database "MOTHS," using FES. Data should be entered as soon as it is collected and sent to FCCC the same day. The "Analysis Unit names" to use for the CLI folder name will be determined after the Forests have delineated 1989 Analysis Units. Data will be entered into only the database that is applicable to that Unit.

The dataset for MOTHS will be used to run the program module "MOTHS," in the WESTBUDS system at FCCC. This program will determine the average number of western spruce budworm moths trapped in each block. The output table will also provide the predicted defoliation levels over each block for 1989. Projects, drawers, folders, and Analysis Unit numbers are:

[illegible] at the same time that [illegible]
[illegible] probably around the middle of July.

[illegible] at each of 13 Evaluation Plot sites in each of the [illegible] Each trap will be hung on the [illegible] of a lower [illegible] or higher [illegible] open-grown host trees. Traps will [illegible] to the trunk [illegible] the end [illegible] branch [illegible] distance. The wire stem will be [illegible] over the [illegible] brought back [illegible] the branch [illegible] slightly to the underside of the [illegible] will [illegible] off the branch, especially during windy conditions.

[illegible] Delta sticky trap [illegible] will be baited with [illegible] of the principle components of the naturally [illegible] (E-11 and Z-11 tetradecenal) [illegible] in a PVC pellet. Traps will be left without servicing through [illegible] retrieved as soon as possible after [illegible] preferably by the [illegible] week of September. Numbers of budworm [illegible] will be counted and recorded [illegible] data will be recorded on the [illegible] copy of Biological Form No. 8, see Appendix [illegible]

[illegible] Entry and Report Generation

[illegible] will be entered into a database and summarized [illegible] of the USDA Forest Service Data Control (DC) system.

[illegible] of the writing of this plan, a system for handling and [illegible] data has not been developed for use on personal computers. It [illegible] instructions and training will be provided [illegible]

[illegible] the DC system is used [illegible] data from [illegible] Form No. 1 will be entered into the [illegible] collected and sent [illegible] The [illegible] Data [illegible] 1989 Analysis Tables. Data will be [illegible] only the database [illegible] applicable to that [illegible]

[illegible] will be used [illegible] This program will [illegible] the average [illegible] budworm moths trapped in each [illegible] and [illegible] data.

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	MOTHS	138
WARM SPRINGS (special)	WARM_SPRINGS_S	MOTHS	148

POST-TREATMENT DEFOLIATION ESTIMATES

Objective

Post-treatment defoliation will be estimated to establish a baseline defoliation level against which to compare following years of defoliation, as a measure of long-term effectiveness of B.t. treatment.

Timing

Post-treatment defoliation measurements will be taken near the end of August when pheromone traps are retrieved.

Sampling Plan and Procedure

Two mid-crown branch samples will be collected from each of the three sample trees on each of the same 13 Evaluation Plots at which pheromone traps had been placed. After the midcrown branch sample is clipped using pole pruner with collecting basket, the defoliation will be rated for a total of 20 new (current year's) buds or shoots on each branch. The following defoliation index will be used to rate each new shoot:

Percent Defoliation	Defoliation Index
0	1
1-25	2
26-50	3
51-75	4
76-99	5
100	6

Defoliation data will be recorded on the Spruce Budworm Defoliation Sheet (white copy of Biological Form No. 8, Appendix B).

ADP Entry and Report Generation

Data will be entered into a database and summarized using either a personal computer or the USDA Forest Service Data General (DG) system.

As of the writing of this plan, a system for handling and summarizing data has not been developed for use on personal computers. If a system is developed and a decision made to use it, instructions and training will be provided before the start of the Project.

If the DG system is used, defoliation index data from the Spruce Budworm Defoliation Data Sheet will be entered into the DG database file "DEFOLIATE," using FES. Data should be entered the same day as collected and sent to FCCC daily, to keep data files current. Data should be entered into only the database that is applicable to that location. Projects, drawers, folders, and Analysis Unit numbers are:

PROJECT	DRAWER	FOLDER	AU NUMBER
BARLOW (special)	BARLOW_S	DEFOLIATE	138
WARM SPRINGS (special)	WARM_SPRINGS_S	DEFOLIATE	148

The dataset for DEFOLIATE will be used to run the program module "DEFOLIATE," in the WESTBUDS system at FCCC. This program will determine the frequency of shoots falling into each of the six defoliation classes described.

LITERATURE CITED

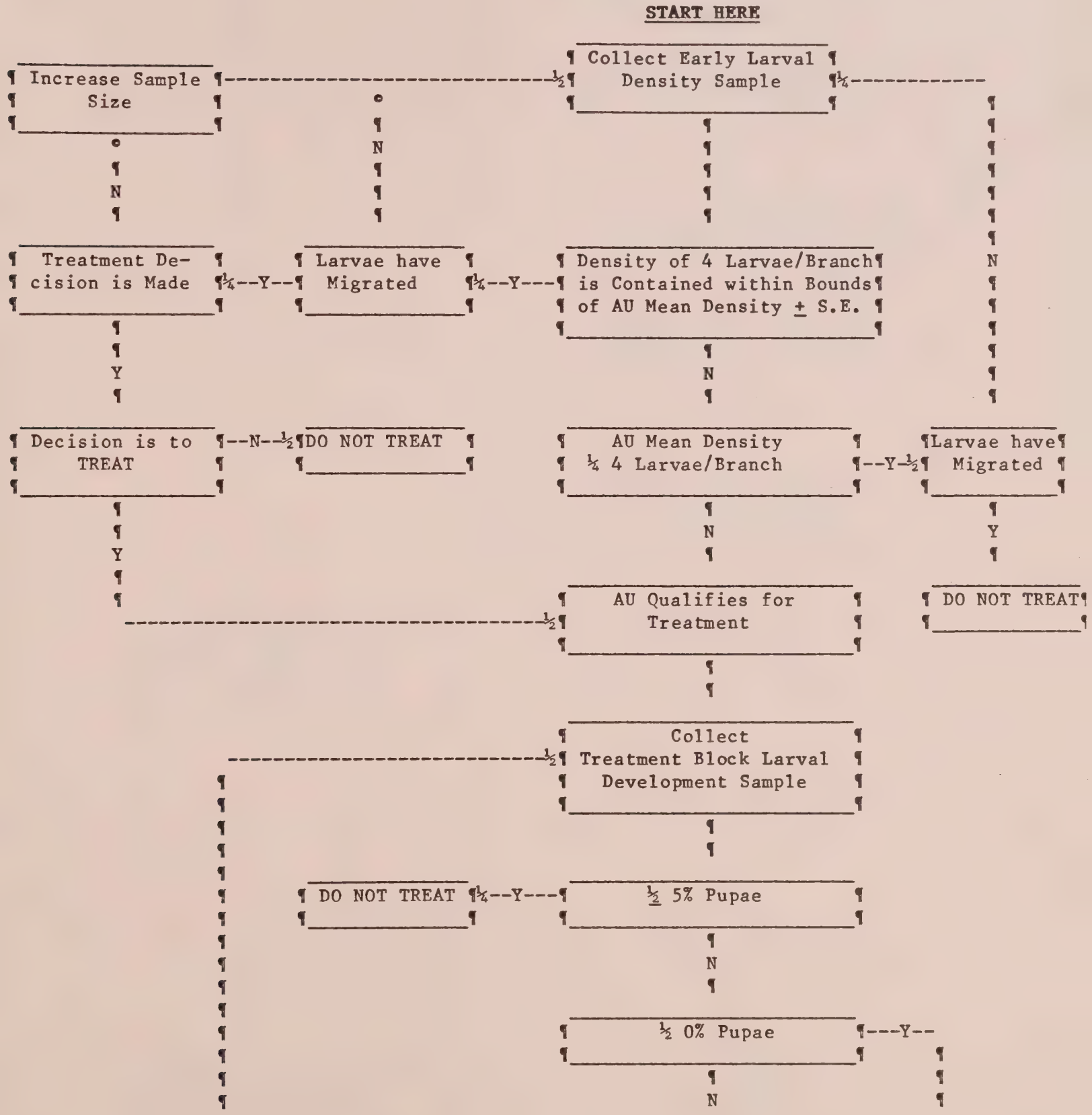
Williams, C. B., Jr., D. A. Sharpnack, L. Maxwell, P. J. Shea, and M. D. McGregor. 1985. Guide to testing insecticides on coniferous forest defoliators. USDA For. Serv. Gen. Tech. Rep. PSW-85, 38p., Pac. Southwest For. and Range Exp. Stn., Berkeley, CA.

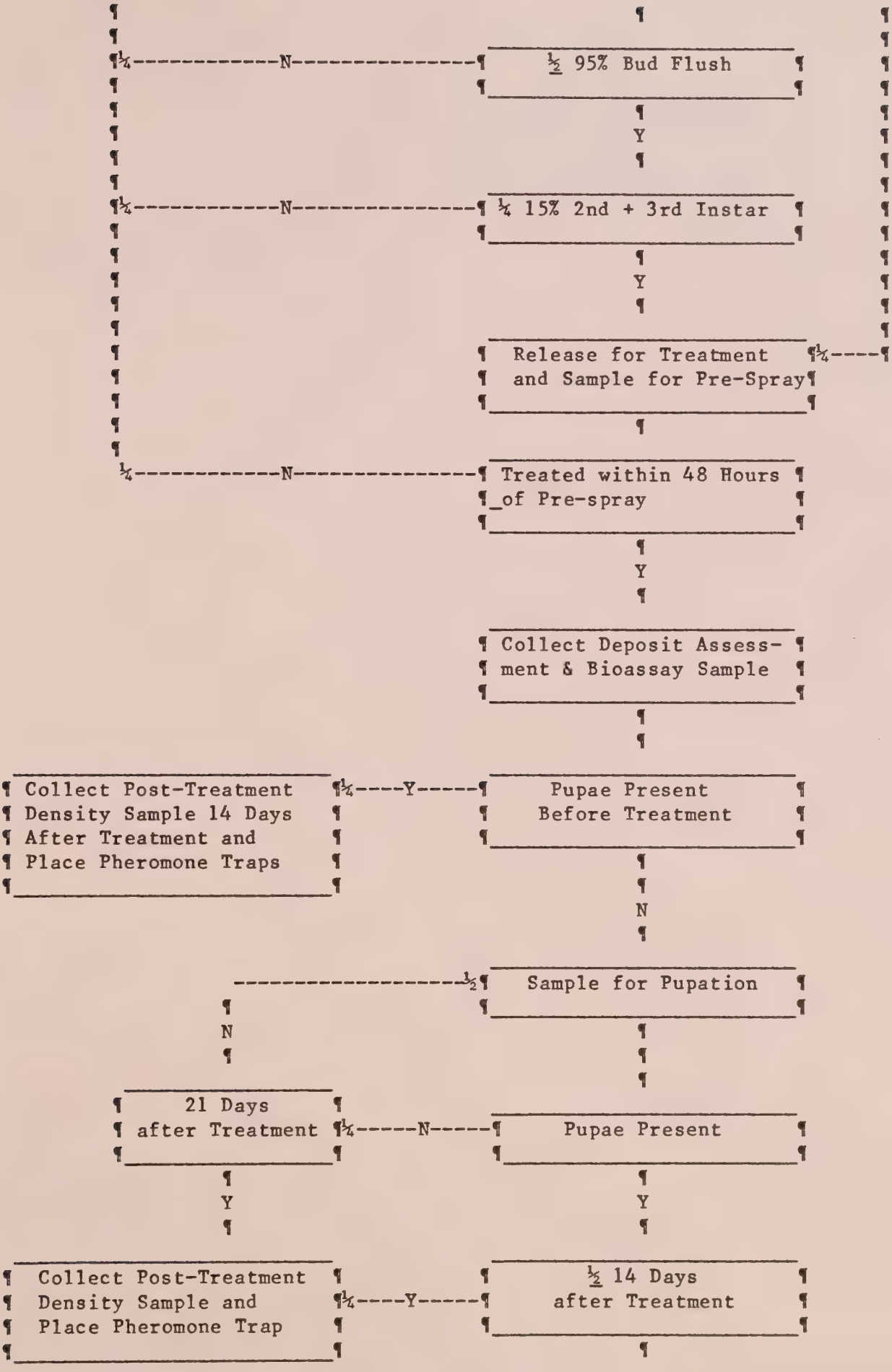
Appendix A

DECISION DIAGRAM FOR SAMPLING AND TREATMENT

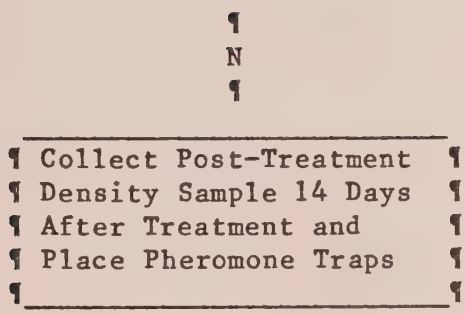
DECISION DIAGRAM FOR SAMPLING AND TREATMENT

1988 Western Spruce Budworm Suppression Project




≥ 95% Bud Flush
N
Y
≥ 15% 2nd + 3rd Instar
N
Y
Release for Treatment and Sample for Pre-Spray
Treated within 48 Hours of Pre-spray
N
Y
Collect Deposit Assessment & Bioassay Sample
Collect Post-Treatment Density Sample 14 Days After Treatment and Place Pheromone Traps
Y
Pupae Present Before Treatment
N
Sample for Pupation
N
21 Days after Treatment
N
Pupae Present
Y
Y
Collect Post-Treatment Density Sample and Place Pheromone Trap
Y
≥ 14 Days after Treatment

[illegible]


N
Collect Post-Treatment
Density Sample 14 Days
After Treatment and
Place Pheromone Traps

APPENDIX 4

FOLIAGE DEPOSIT ASSESSMENT SUB-PLAN

(Plan will be provided when delivered by RPC contractor)

SPRAY DEPOSIT KROMEKOTE SAMPLING

Sub Plan To

DIPEL 6L SPECIAL PROJECT TECHNICAL EVALUATION PLAN

May 1988

INTRODUCTION

Spray deposit sampling is a field method employed to determine if an area was treated. If the spray is dyed or contains a color tracer, the spray drops usually are visible as stains on the sampler. Customarily, white Kromekote paper is used as the sampler and the deposited drops are counted and sometimes measured. The cards are best suited for low volume and high volume spray application. The drop size (drop diameter) of the spray can be estimated by measuring the stain left by the drop depositing on the card. The stains, however, must be visible and the spread factor known. For field estimates of drop size, a factor of 2 is used for water base sprays and a factor of 3.5 to 6 is used for oil base sprays. Oil stains continue to spread for several days because of the low volatility of oil. The drop may spread 3.5 times its diameter in 24 hours and 6 times its diameter in 168 hours. Stains with diameters between 50 and 100 micrometers can be measured with 7X hand-held magnifiers. Automated assessment with image analyzers is usually limited to stains with diameters greater than 100 micrometers.

Deposit papers are inefficient samplers for small drops such as the size range in ULV sprays. Foliage on the other hand is an efficient sampler of small drops. In fact, foliage is so efficient that few drops reach the forest floor. Therefore, deposition at ground level near tree dripline would be considerably less than deposit in forest openings.

Spray deposit sampling provides a simple and inexpensive qualitative sampling technique. As a qualitative sampler it is a suitable procedure to determine whether an area was treated.

To increase the deposition (number of drops) on Kromekote paper, deposit samplers can be elevated. This procedure increases the number of potential drops available to deposit as there is less vegetation available to compete for the drops.

OBJECTIVE

The objective of spray deposit sampling with Kromekote cards is to determine qualitatively the relative amount of spray that reached the sample plots and to check on the degree of spray atomization.

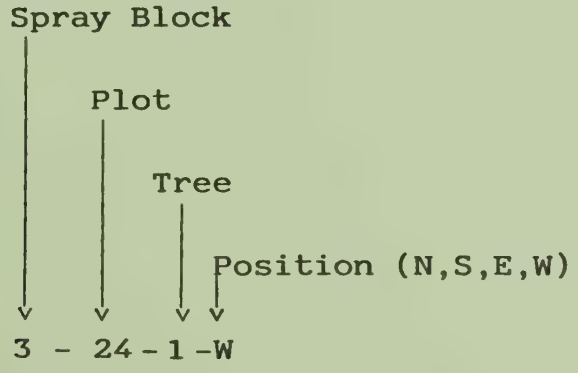
METHOD

Kromekote card samplers will be positioned at each of the 25 plots in each of the three treatment blocks, and in the control block(s).

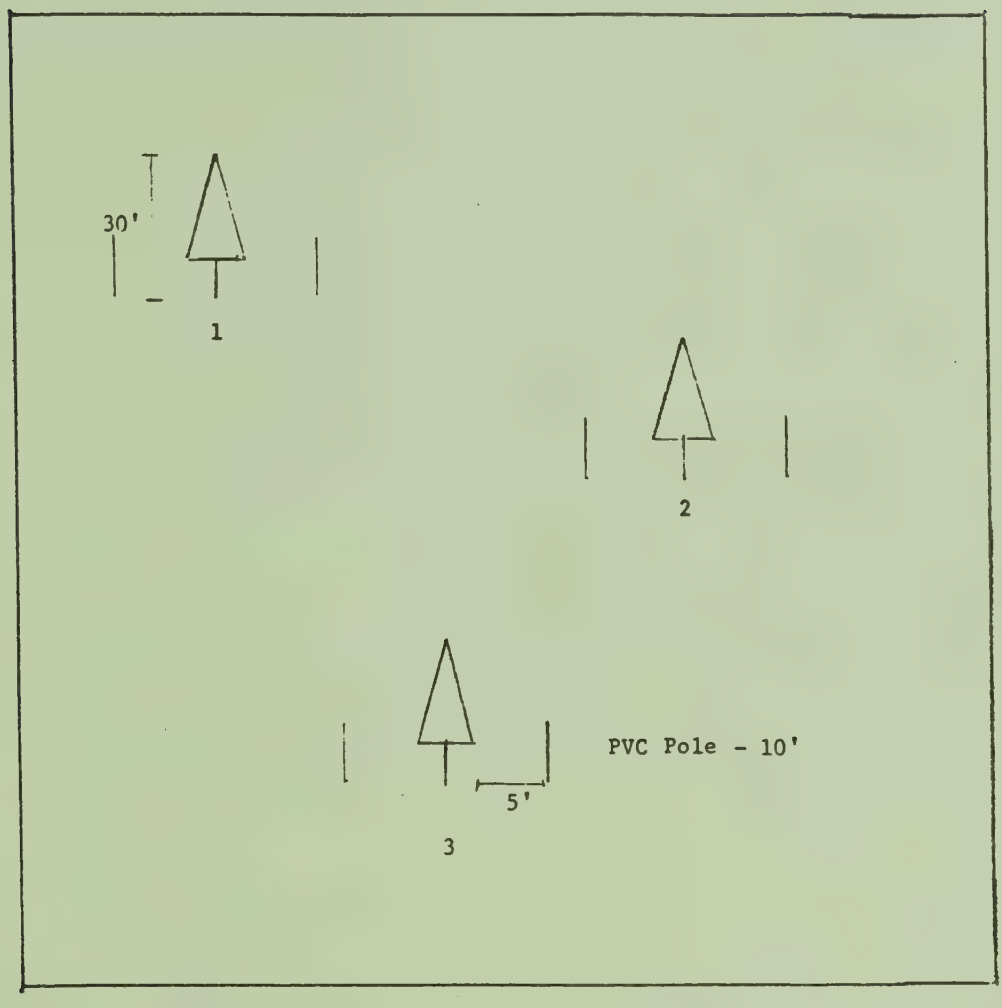
Samplers will consist of Kromekote paper wrapped around a 12 ounce beverage can and a 2" x 2" square of Kromekote placed on the can top. The can, with one end removed, will be slipped over the end of a 10-foot schedule 80 PVC pipe (Figure 1). Two samplers will be positioned at each plot tree. One will be 5 feet from the tree dripline and the other 5 feet from the dripline on the opposite side of the tree (Figure 1). Samplers should be randomly positioned around plot trees relative to cardinal direction. A total of 150 samplers per plot will be required (25 plots x 3 trees per plot x 2 samplers per tree).

The Kromekote paper will be secured with two rubber bands, one near the top and one near the bottom of the can, so as not to disturb the center collecting surface of the card. The 2" x 2" square will then be attached to can top with double-sided adhesive tape.

Cards will be marked with an identification code. The marking should be placed along the bottom edge of the cards and on the same surface being sprayed. Marking code is as follows:



Cylindrical cards will be collected no earlier than 60 minutes after confirmation that the plot has been treated. The cards will be removed from the cans and carefully placed in special spray cardholder boxes, while insuring that the spray deposit on the cards is not disturbed and is protected from dust and other elements that might jeapordize the sample. Once collected the cards will be returned to project headquarters.



LEGEND

PLOT = 1 Acre
3 Trees/Plot
30' High Trees
10' High Samplers
5' Distance From Dripline

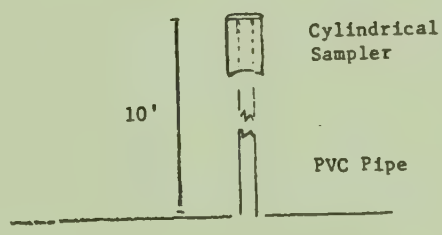


Figure 1 - Position of cylindrical samplers in 1-acre plot.

In the laboratory the cards will be assessed by counting and measuring drops to provide the following information:

1. How well were the plot trees treated on a relative basis?

2. What was the drop density expressed in drops per square centimeters?

3. Was the spray system atomizing properly? Were there any leaks?

4. What was the drop size using the "D max" method?

Assessment procedures are described in the following reports:

1. Dumbauld, R.K. and J.E. Rafferty.
1977. Field Manual for Characterizing Spray From Small Aircraft. USDA Forest Service, Davis, CA.

2. Barry, J.E., R.B. Ekblad, G.P. Markin, and G.C. Trostle.
1978. Methods for Sampling and Assessing Deposits of Insecticidal Sprays Released over Forests. USDA Technical Bulletin 1596. USDA Forest Service, Washington, D.C.

OREGON FORESTRY PRACTICES ACT
ALTERNATE PLAN

1988 Western Spruce Budworm Suppression Project

Barlow Treatment Unit

OBJECTIVE

The objective of this alternate plan is to provide alternate practices in the application of Bacillus thuringiensis (B.t.) for the Western Spruce Budworm Project to meet or exceed the Oregon Forest Practices Act.

OAR 629-24-102 states, "The operator, landowner, or timber owner shall comply with OAR 629-24-101 to 629-24-649 unless prior approval has been obtained from the State Forester for alternate practices which provide for equivalent or better results."

BACKGROUND

An Environmental Analysis and Assessment for Western Spruce Budworm in Washington and Oregon was prepared for 1988. In the Assessment, two alternatives were considered in detail: 1) no action, and 2) treatment with Bacillus thuringiensis (B.t.), a biological insecticide. Approximately 700,000 acres have been identified for treatment on the Mt. Hood, Umatilla, Wallowa-Whitman National Forests, the Warm Springs and Umatilla Indian Reservations, and adjacent other Federal, State, and private lands in Oregon.

B.t. is a naturally occurring bacterium commonly found in the environment. It is the active ingredient of several commercial formulation and trade names. The formulation used on the Barlow Treatment Unit will be an Abbott Laboratories formulation, Dipel 6L. This formulation is registered for the control of western spruce budworm.

The B.t. will be applied one time at the rate of 16 BIU's (Billion International Units) in 42.7 oz. per acre, undiluted. No sticker or spreading agent will be added to the formulations.

B.t. acts specifically against many species of Lepidopterous larvae. Its mode of action is as a stomach poison which causes cessation of feeding. Tests have shown that it is not phytotoxic and has no toxicity to predators, parasites, mammals, birds, or fish. The formulation is not label restrictive to prohibit its application over water.

Forest Pest Management personnel have consulted with the U.S. Department of Interior, Fish and Wildlife Service on the occurrence of Federally Listed Threatened or Endangered Species. There are no threatened or endangered plant or animal species in the project area. Disturbance to other wildlife species will be kept to a minimum.

PROPOSAL

The western spruce budworm spray project is scheduled to be conducted between May 25 to July 15, 1988, depending on insect development. Therefore, approval is requested for this alternate plan covering the following specific rules:

1. OAR 629-24-200 states, "Chemicals perform an important function in the growing and harvesting of forest tree species. The purpose of these rules is to regulate the handling, storage, and application of chemicals in such a way that the public health and aquatic habitat will not be endangered by contamination of waters of the state."

Guidance: The FPA rules define "contaminate" as "....the presence in the atmosphere, soil, or water of sufficient quantities of chemicals as may be injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, or recreational uses, or to livestock, wildlife, fish, or other aquatic life."

Studies have determined that B.t. has no adverse health effect on any human or like forms other that the larvae of Lepidopterous species when properly applied according to the registered label.

Few houses occur within the treatment area. Approval is requested for aerial application of B.t. onto sensitive areas, such as houses, campgrounds, and wildlife habitat.

2. OAR 629-24-203 states, "...protect waterways and areas of open water such as swamps or impoundments from contamination when spraying chemicals by aircraft by leaving an unsprayed strip of at least 60 feet on each side of every Class I water or area of open water.

" ....chemical spray application in or adjacent to the riparian area of influence shall be made parallel to waterways, and must be made prior to application to the remainder of the area to be treated.

" ....No untreated strip is required to be left by the operator when applying fertilizers, except that precautions be taken to avoid direct application of fertilizers to Class I waters or areas of open water."

B.t. has been determined by studies to have no adverse effects when applied over waters.

Buffer strips along streams often consist of Douglas-fir and true firs, which create an environment which is very attractive to western spruce budworm, and would be a source for reinfestation for the treated area if left untreated.

Approval is requested to apply B.t. aerially on buffer strips by flying parallel to Class I (Forest Service Class I and II) streams. There will be no direct application of B.t. to the water of these streams.

3. OAR 629-24-205 states, "Apply chemicals only in accordance with currently recognized limitations of temperature, humidity, wind, and other factors specified by the State Forester."

Two of the weather limitations by the State Forester are that spraying will not occur if the winds exceed 5 miles per hour or if the relative humidity is below 50 percent.

The Dipel 6L formulation will be applied at a droplet size of about 50 microns VMD. The manufacturer recommends that effective application can be achieved in winds up to 12 miles per hour with this product at the targeted droplet size.

Environmental documents, such as the 1985 USDA Gypsy Moth Final Environmental Impact Statement has determined that effective aerial application of B.t. can be made in winds up to 10 miles per hour.

Therefore, approval is requested to effectively apply B.t. aerially in winds not to exceed 12 miles per hour.

The Dipel 6L formulation is an oil base formulation, and therefore, not subject to evaporation in lower humidities, as are water base formulations.

Therefore, approval is requested that the humidity limitation be waived for the application of the Dipel 6L product.

Approved by: by /s/ F. Shaf Eastern Oregon Area Director
James E. Brown, State Forester

4/16/88
Date